98th Congress
1st Session } COMMITTEE PRINT { S. Prt. 98-131

GROUNDWATER CONTAMINATION BY TOXIC SUBSTANCES: A DIGEST OF REPORTS

A REPORT

PREPARED BY THE

ENVIRONMENT AND NATURAL RESOURCES
DIVISION

OF THE

CONGRESSIONAL RESEARCH SERVICE

OF THE

LIBRARY OF CONGRESS

FOR THE

COMMITTEE ON ENVIRONMENT
AND PUBLIC WORKS
U.S. SENATE

NOVEMBER 1983

Printed for the use of the Committee on Environment and Public Works

U.S. GOVERNMENT PRINTING OFFICE
27-471 O WASHINGTON: 1983

3322-1

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

ROBERT T. STAFFORD, Vermont, *Chairman*

HOWARD H. BAKER, Jr., Tennessee	JENNINGS RANDOLPH, West Virginia
JOHN H. CHAFEE, Rhode Island	LLOYD BENTSEN, Texas
ALAN K. SIMPSON, Wyoming	QUENTIN N. BURDICK, North Dakota
JAMES ABDNOR, South Dakota	GARY HART, Colorado
STEVE SYMMS, Idaho	DANIEL PATRICK MOYNIHAN, New York
PETE V. DOMENICI, New Mexico	GEORGE J. MITCHELL, Maine
DAVE DURENBERGER, Minnesota	MAX BAUCUS, Montana
GORDON J. HUMPHREY, New Hampshire	

BAILEY GUARD, *Staff Director*
JOHN W. YAGO, Jr., *Minority Staff Director*

Congressional Research Service
The Library of Congress

Washington, D.C. 20540

LETTER OF SUBMITTAL

July 5, 1983

Honorable Robert T. Stafford
Chairman, Committee on Environment
and Public Works
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

The enclosed document, Groundwater Contamination by Toxic Substances: A Digest of Reports," is submitted in response to your request for an update of the "Resource Losses from Surface Water, Groundwater, and Atmospheric Contamination: A Catalog," which we prepared for the Committee in 1980. As explained in the introduction to this document, the increase in information since the earlier document made a new catalog, as such, unfeasible to replicate here. Therefore, we have prepared a digest of the many existing reports concerning groundwater contamination.

The reports digested were collected and reviewed by Mr. Phil Jalbert, a Presidential Management Intern, under the direction of John E. Blodgett, Specialist of the Environment and Natural Resources Policy Division. Claudia Copeland, Specialist in Environmental Protection, also provided assistance.

By collecting in one place information about studies of groundwater contamination, this digest should greatly facilitate further research into this topic. We hope that you will find it useful. We remain available to provide further assistance in studying this timely issue.

Sincerely,

Gilbert Gude

Gilbert Gude
Director

Enclosure

[illegible], VT., [illegible]

[illegible] | [illegible]
[illegible] | LLOYD BENTSEN, TEX.
[illegible] | [illegible]
[illegible] | GARY HART, COLO.
[illegible] | [illegible]
[illegible] | [illegible]
[illegible] | [illegible]
[illegible]

[illegible], STAFF DIRECTOR
[illegible], MINORITY STAFF DIRECTOR

United States Senate
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
WASHINGTON, D.C. 20510

January 5, 1983

Honorable Gilbert Gude
Director
Congressional Research Service
Library of Congress
Washington, D.C. 20530

Dear ~~Mr. Gude~~ Gil:

At the request of the Senate Environment and Public Works Committee, the Environment and Natural Resources Policy Division of the Congressional Research Service prepared in 1980 "A Catalog" of Resource Losses from Surface Water, Groundwater, and Atmospheric contamination. The 98th Congress will be returning to the issues of resource losses in general and to groundwater pollution problems in particular. We are therefore requesting the Congressional Research Service to update the groundwater portion of that report.

The format of the earlier report is appropriate for the update of the "catalog." In addition, a discussion of the adequacy of data sources would provide a useful introduction. We would appreciate receiving the report by mid-April, with the expectation that it would be published as a Committee Print.

Any further questions should be addressed to Mr. Curtis Moore of the Committee staff. He has already had preliminary discussions concerning this request with Mr. John Blodgett of the Environment and Natural Resources Policy Division.

Sincerely yours,

Robert T. Stafford
Chairman

GROUNDWATER CONTAMINATION BY TOXIC SUBSTANCES
A Digest of Reports

Prepared At The Request Of Senator Robert T. Stafford
Senate Committee On Environment And Public Works

by
Environmental Protection Section,
John E. Blodgett, Section Head
Research Support by Phil Jalbert,
Presidential Management Intern
Environment and Natural Resources Policy Division

June 10, 1983

"It's everybody's water, it's everyone's environment, it's got to be done."

A temporarily displaced Swartz Creek resident commenting on the start of a toxic waste dump clean-up in this community near Flint, Michigan. Groundwater in the area is believed to be contaminated. The dump is rated number 16 on the Superfund list.

The CBS Evening News, April 20, 1983

GROUNDWATER CONTAMINATION BY TOXIC SUBSTANCES

TABLE OF CONTENTS

INTRODUCTION xi

DISCUSSION xv

PART ONE: FEDERAL SOURCES 1

Section One: U.S. Environmental Protection Agency [EPA]

1. DRINKING WATER SUPPLIES CONTAMINATED BY ORGANIC CHEMICALS IN NEW ENGLAND ... 3
2. OCCURRENCE OF ORGANIC CHEMICALS IN DRINKING WATER, AIR AND FOOD 7
3. ASSESSMENT OF HAZARDOUS WASTE MISMANAGEMENT: DAMAGE CASE HISTORIES 9
4. SURFACE IMPOUNDMENT ASSESSMENT: NATIONAL REPORT, and SURFACE IMPOUNDMENTS AND THEIR EFFECTS ON GROUND-WATER QUALITY IN THE UNITED STATES: A PRELIMINARY SURVEY 12
5. INSTITUTIONAL RESPONSES TO CONTAMINATION OF GROUND WATER USED FOR PUBLIC WATER SUPPLIES 16
6. COMPENDIUM OF CASES OF GROUND WATER CONTAMINATION 19
7. NATIONAL GROUND WATER SUPPLY SURVEY [GWSS] 21
8. DAMAGES AND THREATS CAUSED BY HAZARDOUS MATERIAL SITES 24
9. THE REPORT TO CONGRESS: WASTE DISPOSAL PRACTICES AND THEIR EFFECTS ON GROUND WATER 26
10. GROUNDWATER POLLUTION PROBLEMS IN THE SOUTHEASTERN UNITED STATES 28
11. GROUND-WATER POLLUTION PROBLEMS IN THE NORTHWESTERN STATES 29
12. GROUND WATER CONTAMINATION IN THE NORTHEAST STATES 29
13. GROUND WATER POLLUTION IN THE SOUTH CENTRAL STATES 30
14. GROUND WATER POLLUTION IN ARIZONA, CALIFORNIA, NEVADA, UTAH 31
15. NATIONAL STATISTICAL ASSESSMENT OF RURAL WATER CONDITIONS, and RURAL WATER SURVEY [RWS] 32
16. COMMUNITY WATER SUPPLY SURVEY [CWSS] 32
17. IDENTIFICATION OF ORGANIC COMPOUNDS IN EFFLUENTS FROM INDUSTRIAL SOURCES ... 33

Section Two: U.S. Geological Survey [USGS]
1. USGS PUBLICATIONS CONCERNING GROUND-WATER CONTAMINATION INCIDENTS 35
2. NATIONAL WATER DATA EXCHANGE [NAWDEX] 36

Section Three: Council On Environmental Quality [CEQ]
1. CONTAMINATION OF GROUND WATER BY TOXIC ORGANIC CHEMICALS 40

PART TWO: STATE SOURCES 41

1. CALIFORNIA
    [DHS] REPORTS CONTAINING GROUNDWATER CONTAMINATION INFORMATION 43
2. CALIFORNIA
    [SWRCB] REPORTS CONTAINING GROUNDWATER CONTAMINATION INFORMATION 46
3. CONNECTICUT
    ANNUAL OIL AND CHEMICAL SPILL SUMMARY FOR FY 1981-1982 48
4. CONNECTICUT
    SUPPLIES WHICH HAVE EXCEEDED THE SNARLs* FOR ORGANICS 49
5. FLORIDA
    FLORIDA GROUND WATER CONTAMINATION SITES 50
6. ILLINOIS
    GROUND-WATER CONTAMINATION: PROBLEMS AND REMEDIAL ACTIONS 52
7. MASSACHUSETTS
    CHEMICAL CONTAMINATION 53
8. MICHIGAN
    ASSESSMENT OF GROUNDWATER CONTAMINATION: INVENTORY OF SITES 54
9. MINNESOTA
    HAZARDOUS WASTE LOG 55
10. MINNESOTA
    VOLATILE ORGANICS SAMPLING 56
11. NEW JERSEY
    GROUND WATER POLLUTION INDEX 58

12. NEW YORK
ORGANIC CHEMICALS AND DRINKING WATER 59
13. PENNSYLVANIA
WATER QUALITY INVENTORY, 1982 60
14. SOUTH CAROLINA
INVENTORY OF KNOWN GROUND-WATER CONTAMINATION CASES AND GENERALIZED DELINEATION OF FIVE GROUND-WATER RECHARGE AREAS IN SOUTH CAROLINA 64
15. TENNESSEE
PROFILE OF EXISTING GROUNDWATER PROBLEMS IN TENNESSEE 65
16. UTAH
A SURVEY AND EVALUATION OF SHALLOW GROUNDWATER CONTAMINATION HAZARDS IN THE STATE OF UTAH 67
17. VERMONT
VERMONT UNDERGROUND INJECTION PRACTICES AND GROUNDWATER CONTAMINATION INCIDENTS SURVEY 68

PART THREE: INSTITUTIONAL and COMMERCIAL SOURCES 69

1. ACADEMY OF NATURAL SCIENCES
GROUND WATER CONTAMINATION IN THE UNITED STATES 70
2. WATER WELL JOURNAL PUBLISHING COMPANY
ALERT 71
3. WATER INFORMATION CENTER, INC.
THE GROUND WATER NEWSLETTER 72
4. NATIONAL GROUND WATER INFORMATION CENTER
NATIONAL GROUND WATER INFORMATION CENTER DATA BASE 73

APPENDIX 75

LIST OF TABLES

DISCUSSION

Table A Summary of State Data on Contaminated Drinking Water Wells xxviii

ENVIRONMENTAL PROTECTION AGENCY [EPA]

Table 1 Profile of the Probable Sources of Contamination 4
Table 2 Drinking Water Wells Closed or Affected; by State 4
Table 3 Distribution of Chemicals Identified in Drinking Water Samples 5
Table 4 Frequency of Chemicals in the 124 Incidents/Water Samples 6
Table 5 CRS Analysis of "Table A: Summary of Evaluated Sites" 10
Table 6 Surface Impoundment Summary 14
Table 7 Contaminated Drinking Water Wells; 77 Cases 16
Table 8 GWSS Data Summary of Public Water Supply Systems 22
Table 9 Summary of Groundwater Contamination Incidents 25

COUNCIL ON ENVIRONMENTAL QUALITY [CEQ]

Table 10 Chemical Concentrations Measured in Surface Water versus Groundwater .. 40

CALIFORNIA

Table 11 California Action Levels for Selected Chemicals 44

PENNSYLVANIA

Table 12 Groundwater Contamination Cases and Estimated Acres Affected; by COWAMP Area 61
Table 13 Occurrence of Contamination Cases; by Type and COWAMP Area 62

APPENDIX

Table 14 U.S. EPA Drinking Water System Size Categories 75
Table 15 Annual Fresh Groundwater Withdrawals in the United States [1980] 76

GROUNDWATER CONTAMINATION BY TOXIC SUBSTANCES

INTRODUCTION

This Digest was prepared at the request of Senator Robert T. Stafford, Chairman of the Committee On Environment And Public Works. It was written by the Environment and Natural Resources Policy Division of the Congressional Research Service of the Library of Congress. This undertaking began as an update to "Resource Losses From Surface Water, Groundwater, And Atmospheric Contamination: A Catalog." The report was prepared at the request of Senator Edmund S. Muskie, Chairman, and Senator Robert T. Stafford, Ranking Minority Member of the Subcommittee on Environmental Pollution. The report was published as a committee print in March 1980.

When we began the search for cases of water wells affected or closed by toxic contamination, we found many new reports. In looking at these, numerous references like the following were found:

"...One case [of groundwater contamination] caused more than 50 domestic wells to be closed...."

"...Aquisition and review of the records of the hundreds of past and recent case histories [of groundwater contamination], which are believed to be in State and EPA files, would have required an expenditure of time and funds beyond the scope of this study."

"...Incidents of [local] groundwater contamination are too numerous to include...."

This observation led us to conclude that it would be extremely difficult and time consuming to locate, summarize and list individual incidents per se, as had been done in the 1980 CRS catalog. This review shows that many more incidents have been identified, but the majority of information relating to groundwater contamination remains anecdotal, scattered, and poorly organized.

Therefore, to respond to Senator Stafford's request, CRS has prepared this Digest of existing reports on groundwater contamination. It is basically an annotated bibliography designed to acquaint the reader with many of the reports on the subject and to summarize their primary findings. A total of 41 reports and information sources are digested, most of them recent - some still in draft form.

The nature of the Digest and the quality and kind of information it contains require two important caveats. First, the reports [indexes, lists, studies] are presented without the benefit of any follow-up to confirm the current status of individual incidents, except to clarify general information and confirm interpretations. The principal factors which affected the selection of these documents over others included time constraints, the identification of sources, and the availability of data.

Second, extreme caution should be exercised in generalizing about the set and its content. As a sample, these report summaries are incomplete and not intended to be statistically representative. Also, this information is time sensitive and its status changes constantly. Further, many of these studies were generated as a result of specific and sometimes differing regulatory concerns. For example, a number of the reports derive from reviews of hazardous waste sites initiated because of the Resource Conservation and Recovery Act [RCRA], and the Comprehensive Environmental Response, Compensation and Liability Act [CERCLA or Superfund]. Therefore the sources of contamination identified may be skewed toward that problem.

The analytic orientation used in summarizing the information presented in the documents collected was based on a triad of parameters: groundwater, drinking water wells, and contamination by toxic substances. Toxic substances were defined to include the following contaminants: synthetic organic chemicals, heavy metals, pesticides, herbicides, fungicides, gasoline, and other finished petroleum products.

The titles included in the Digest in most instances indicate the primary concern and purpose behind the report's preparation. The topics addressed in the Digest's Federal and State reports range widely. The reports provide information in varying degree of detail and form, which CRS reviewed and summarized. The information on contamination incidents they contain was analyzed and organized into 17 tables. This information does not appear in this form in the original documents unless otherwise noted.

Many Federal reports specifically address a type of contamination, such as organic chemicals in drinking water, while others more generally address a source of contamination, such as surface impoundments. For example, many EPA reports focus on volatile organic chemicals [VOC], waste disposal practices, industrial pollution and damage cases, hazardous materials generally, and the quality of a particular class of water supply: for instance, one dependent on groundwater.

Many States collect information about the incidence of drinking water contamination, and the degree to which wells are affected. This information is often found in a variety of agencies and their files because of the typically fragmented responsibility for drinking water and groundwater in many States. Agencies with responsibilities for other than just drinking water, such as public health, mining, agriculture, or water allocation, may collect this type of information.

For example, Maryland included 10 cases of documented or suspected groundwater contamination in its 1980 Surface Impoundment Assessment [SIA] for EPA. The information was compiled by examining the files and interviewing officials from no less than eight different State agencies, from the Attorney General to the State Bureau of Mines. The information is collected by these agencies for different reasons and with varying emphases, and is not comparable between agencies, let alone between States.

Certain reports included in the Digest are updated editions of earlier work. Some show marked increases in the number of reported incidents or cases compared to previous years. For example, in 1982 Michigan reported 897 known and suspected cases of groundwater contamination, an increase of 248 from the 649 listed in 1979. These changes are probably explained in part by the development of improved data collection systems and/or the rising incidence of contamination. The public awareness and concern expressed over drinking water quality and environmental pollution generally is also helping to promote data collection efforts.

Contamination of groundwater crosses the boundaries of essentially arbitrary classifications. The most commonly used typologies distinguish between (1) Type of Activity [industrial, agricultural, household], (2) Contaminant [volatile organic chemical, gasoline, nitrates, heavy metals], and (3) Source [land disposal of sludge, septic systems, landfills, storage tanks].

Even after numerous groundwater related studies conducted by EPA and other Federal agencies, no integrated or comprehensive data base has been constructed to meet the pressing data requirements for developing the policies and plans needed for effective management of groundwater quality and quantity now and in the future.

The author has taken the liberty of using "groundwater" as one word in the Digest, except of course, when it appears in a title or quote.

DISCUSSION

The following discussion was written with two objectives in mind: to present a profile of the Digest's contents, and to provide the reader a perspective, or framework, for assessing the information contained in the summaries and Digest as a whole.

The Groundwater Resource

Nationwide, approximately 112 million people get their drinking water from the ground; about 90% of all rural households depend on groundwater for their water supply. In an average household, only about 5% of all fresh water used is for drinking water. The single largest household use is for the flushing of toilets.

Groundwater is more widely available and accessible than surface water. The groundwater milieu is dynamic and characterized by temporal, spatial, and geologic parameters. It is essentially an "invisible" resource, except when flowing from a spring or well. During dry periods groundwater discharge is often the most important source of water for streams in humid regions. Groundwater typically has a much slower flow cycle than surface water. Rate of flow, as a horizontal measurement, can vary widely depending on the geologic formation. For example, the flow rate over a given gradient in gravel could equal 60 feet per day (18 meters) compared to 1 foot per day (.3 meters) in clay. The average is between two and twelve feet per year.

Groundwater can also flow vertically between different geologic layers and aquifers. This natural aquifer exchange is often modified by human activity. For example, in Illinois and Indiana, a severe problem exists with the inter-aquifer transport of brines, caused by the drilling and abandonment of thousands of old oil and gas wells - the heritage of a significant oil and gas drilling industry.

In 1981, the Water Resources Council [WRC] estimated that there are between 33 and 59 quadrillion gallons of fresh groundwater within 1/2 mile of the earth's surface in the United States. This is equivalent to four times the volume of the Great Lakes. In 1980, of the 34 billion gallons used for public drinking water, 6.6 billion gallons or 12% came from groundwater.

Wells

The three principal categories of drinking water wells are: private, municipal, and industrial:

- Private wells typically serve individual houses or very small water systems serving less than 25 people. They are probably the most numerous and are usually drilled or dug.

- Municipal wells are often grouped in a wellfield. Some municipal systems rely solely on groundwater, and an unknown number of water systems blend some amount of groundwater with surface water before distributing it.

- Industrial water wells are generally of two types: drinking and process, and are at times indistinguishable. For example, a cereal food manufacturer may satisfy the drinking water requirement of his employees, and use water from the same well in the production process. Although this type of well is fairly common, it is not often listed in the summaries discussed in the Digest, except when implicated in a documented case of groundwater contamination.

Regulation

The regulation of the quality of well water is fragmented and confusing. Public water supplies and wells are often regulated by State public health agencies whose regulatory programs vary widely, and testing for contamination by toxics is seldom required. Private wells, both for drinking water and other uses, may be regulated by State environmental protection agencies, and again testing for toxics is rarely required. The Federal Environmental Protection Agency [EPA] has no jurisdiction over private water supplies or wells.

The EPA has jurisdiction over all Community and Non-Community Public Water Supplies under the Safe Drinking Water Act [SDWA][see Table 14]. A public water supply is defined as serving a minimum of 25 persons or having 15 connections. The SDWA's Interim Primary Drinking Water Regulations require community public water supplies to regularly test for several inorganic and organic chemicals, turbidity, microbiological and radiological contaminants. The non-community water supplies, with less stringent minimum requirements, test quarterly for microbiological contaminants, turbidity if from surface water, and one time only for nitrate.

Sources of Contamination

Historically, synthetic organic chemicals, gasoline, heavy metals, finished petroleum products, and other types of hazardous compounds were rarely monitored or tested for in drinking water. Only recently has it been realized that contaminants such as these are increasingly present in drinking water, particularly groundwater. Another reason for infrequent testing is that the cost of testing for such a wide variety of contaminants can be a much as $3,200 per sample.

Sources of contamination are generally classed as either point or non-point. A point source is usually defined as concentrated and large volume, i.e., landfills, hazardous waste dumps, industrial sites, etc. A non-point source is usually defined as numerous, dispersed and having a relatively low volume, i.e., urban and rural runoff, septic systems, underground storage tanks and pipelines, agricultural use of pesticides, mining activity, oil and gas field brines, and pits, ponds, and lagoons used for waste water storage, etc.

Contamination levels in surface water and groundwater are often more noticeable following precipitation. This is because rain water flushes contaminants out of relatively "solid" masses like landfills. This is also true of soil which is contaminated by a chemical spill, and where the soil is to some degree saturated. Concentrations in water often increase dramatically under these circumstances, and measurements in the tens of thousands of parts per billion have been recorded. At concentrations of 10 ppb many synthetic organic chemicals are odorless and tasteless and are consequently difficult to detect without the use of sophisticated laboratory equipment.

Septic systems are less visible in the summaries than might be expected given their large number and wide distribution. This is probably due to the relatively low volume of pollution produced by individual units. However, traces of 1,1,1-trichloroethane, an organic solvent, in groundwater have focused attention on septic systems because it is commonly used as a degreaser in cleaning these systems.

NOTE: Parts per billion (ppb) are roughly equivalent to micrograms per liter (ug/l).

One gallon of trichloroethylene [TCE], another organic solvent, will contaminate 14.6 million gallons of water to a concentration level of 100 parts per billion; see the action levels in Table 11 for comparative purposes. To place this fact in some perspective, consider that in 1979 alone, approximately 400,000 gallons of various chlorinated organic solvents were used in Long Island's septic systems.[1] This means that a maximum of $5.84x10^{12}$ [5.84 trillion] gallons of water may have been contaminated. Also, many of these solvents "volatize", i.e., evaporate readily, and concentrations of any contaminant in groundwater will not necessarily be distributed evenly, they tend to be higher closer to the source.

Inadequate material storage is a generic category of contamination sources fast being recognized as a major contributor to groundwater contamination. Leaks from underground storage tanks and pipelines, especially those used for gasoline, finished petroleum products, hazardous wastes, and industrial solvents such as TCE, are among the leading causes for a very large number of discharges. They often go undetected for long periods of time, or until they adversely affect a water well.

Because gasoline use and storage in underground tanks is so common, a brief characterization is instructive. Contamination of groundwater by gasoline was recognized as a growing problem by James J. Geraghty and David W. Miller of Geraghty and Miller, Inc., who wrote an article in which they claimed that gasoline was "...the principal contaminant reported to public agencies...."[2]

---

[1] "Contamination of Ground Water by Toxic Organic Chemicals," Council on Environmental Quality, p.12, January 1981.

[2] Geraghty, J.J., and Miller, D.W., "Status of Groundwater Contamination in the US," Journal of the American Water Works Association, p.162-167, March 1978.

This observation is supported by the large number of gasoline contamination incidents cited in the Digest's summaries. Recently it has been estimated that 40% of the groundwater contamination now occurring may be caused by the leaking of underground gasoline and petroleum product storage tanks, and pipelines.

An estimated 100,000 buried [steel] gasoline storage tanks will be leaking in 1983.[3] Illustrating the lack of information on the scope of the problem, New Mexico reports 28 documented cases of groundwater contamination by gasoline leaking from tanks, but the State has no record of how many tanks exist, nor their age or location. This problem is compounded by the fact that domestic use of underground tanks may equal or exceed commercial use, i.e., home heating oil, and farm tanks.

The most common test of the integrity of buried tanks - a hydrostatic pressure test - often fails to identify relatively small leaks, i.e., less than 20 gallons per day [2/10 of 1%] from a 10 thousand gallon capacity tank. Yet a 20 gallon per day loss amounts to 7,300 gallons per year. The eight largest U.S. oil companies have reportedly begun a program to hydrostatically test their underground gasoline storage tanks.

The reports included in this Digest were reviewed specifically to identify the sources of contamination causing the various incidents described. The sources identified are listed below, in roughly the order in which they appear to contribute to the groundwater contamination problems reported in the Digest.

---

3 Paul, B., "Leaking Gasoline-Storage Tanks Risk Explosions And Contaminated Water Near Service Stations," Wall Street Journal, p.56, Tuesday, November 16, 1982.

Given the caveats against viewing this Digest as a complete and comprehensive summary of groundwater problems, this list should be viewed as informative, but not in any sense as definitive. These sources account for a wide variety of toxic contaminants; from the use of solvents in dry cleaning and septic systems, to highly toxic and hazardous wastes disposed of by being pumped into deep geologic zones.

1. Industrial and Manufacturing Activity:
    - Improper Handling
    - Metal Cleaning and Electro-Plating
    - Dry Cleaning Activity
2. Underground Storage Tanks:
    - Service Stations/Gasoline, Diesel Oil, Waste Oil
    - Solvents and Hazardous Wastes
    - Large/Small Businesses
    - Military Facilities
    - Home Heating Oil
    - Farm Fuel
3. Underground Pipelines:
    - Finished Petroleum Products
    - Oil
    - Solvents
4. Surface Impoundments:
    - Drainage Basins/Evaporation Ponds
    - Pits
    - Lagoons

5. Landfills and Dumps:
    - Open Dumps & Landfills
    - Hazardous Waste Dumps
    - Land Disposal of Sludges
    - Nuclear Waste Disposal Facilities
6. Septic Systems
7. Drainage and Injection Wells:
    - Oil and Gas Drilling Wastes; Brines primarily
    - Hazardous Wastes
8. Agriculture:
    - Pesticides
    - Fungicides
    - Herbicides
9. Household Use:
    - Chemical Solvents
    - Cleaners
    - Paints
    - Agricultural Chemicals
    - Fertilizers
10. Midnight/Illegal Dumping
11. Transportation Spills:
    - Railroad Tank Car
    - Tank Truck
    - Transfers [storage to storage, or bulk storage to use]

Profile on the Federal Reports

A reading of the Federal reports revealed the following themes - some expressed explicitly and others implicitly - and gave rise to some observations. The reader may find it useful to have these in mind while considering the Digest.

- TCE is perhaps the most common synthetic organic chemical found in drinking water. Human exposure to this ubiquitous chemical is more likely from groundwater rather than surface water, particularly at levels exceeding 5 micrograms per liter.
- EPA studies tend to average between one and three years; the actual research period is often much shorter. And, most studies were conducted only once without follow-up.
- State agencies with a groundwater responsibility are generally understaffed and lack the financial resources needed for effective oversight of surface impoundments, which have a high potential for groundwater contamination.
- Storage site incidents appear more common than those involving disposal sites, perhaps because storage sites are relatively more numerous, and involve large volumes.
- Documentation adequate for the analysis of damage incidents is often lacking.
- The absence of clear guidelines on a "safe" risk or action level for synthetic organic chemicals in drinking water has created regulatory problems for State regulatory and other officials. The health effects associated with water contaminated by volatile organic chemicals is a major concern in this regard.
- The larger a public drinking water system is, the greater the probability of its being contaminated by one or more VOCs, according to EPA in its study on TCE in drinking water, air and food [see EPA Digest summary #2].

- Remedying a groundwater contamination problem can be overwhelmingly expensive. For example, the U.S. Army has already spent more than $200 million to contain and clean-up contaminated groundwater at the Rocky Mountain Arsenal. It expects to spend an additional $1.8 billion or more to complete the work.
- When addressing the issue of drinking water drawn from the ground, considerations of quality and quantity are inseparable.

Profile on the State Reports

A reading of the State reports reveals a somewhat different set of themes and observations which include the following:

- State agencies are now developing management strategies based on existing information, and the lack of it in some cases. In augmenting the existing data base and recognizing the importance of better data, State agencies are beginning to inventory incidents, identify and map known or potential sources of pollution, categorize and delineate aquifers, and identify aquifer recharge zones.

  States which have apparently made progress in this respect include: New York, Michigan, Pennsylvania, Massachusetts, Minnesota, South Carolina, New Jersey, Florida, Connecticut, Wisconsin, and California.
- Most inventories appear to contain only relatively recent information, from the late 1970's to the present. A number of them only began collecting information on a systematic basis in 1980, coincident with the passage of Superfund, and increasing EPA and State activity in the groundwater arena.

- For those States with no inventory or index of groundwater contamination sites, the Surface Impoundment Assessments conducted by all states for EPA in 1980 are a good source of selected case studies.
- State groundwater policy is often complicated by the difficulty in determining the "ambient" or "background" level of water quality. Policies for managing groundwater quality and quantity range from absolute non-degradation, and limited degradation, to the absence of any defined policy.
- State reports show that synthetic organic chemicals, heavy metals, and gasoline are the primary contaminants known to be involved in the pollution of groundwater.
- Many States appear to have concluded that because remedial action for groundwater contamination is complex, time consuming, and expensive, prevention is preferable and more effective. This conclusion is succintly stated in the Massachusetts report: "...Long range planning and comprehensive management of both water supply aquifers and all potentially hazardous materials will be the only economically feasible and environmentally effective approach to protecting our water resources."
- Some States, like Connecticut, have sampled all their community public water supplies at least once for VOCs. Other states, like Minnesota, have just begun similar programs.

- State actions are often initiated because of Federal requirements and/or funding. For example, in Minnesota, the Pollution Control Agency Groundwater Section is preparing a report on groundwater contamination entitled "Contaminated Site Inventory." It was partially funded through a 29-month Section 208/Clean Water Act grant from EPA. Among its preliminary findings is: the closing of public water systems has been due to the presence of VOCs. In Minnesota, the Health Department and Pollution Control Agency have jurisdiction over private and public water supplies, respectively.

Very few States have developed and maintain data bases on groundwater quality which might be considered comprehensive, as typified by the Digest entries. Not all States have published their inventories of groundwater contamination incidents, and some reports are singular events, not planned to be updated or repeated. Despite the variety in approach and scope of the State reports there appears to be considerable agreement, and few contradictions, about the problems associated with groundwater contamination.

Table A, which follows, summarizes the information on contaminated drinking water wells that was derived from the data contained in the summaries of the State reports included in the Digest.

Table A: Summary of State Data on Contaminated Drinking Water Wells

		DRINKING WATER WELLS CONTAMINATED BY TOXIC SUBSTANCES						
		AFFECTED			CLOSED			TOTAL
STATE	ALL CASES	Private	Public	Total	Private	Public	Total	Affected & Closed
1. California	-(a)-	5	133	138	753		753	891
2. California	-(a)-			-			-	-
3. Connecticut	45(c)			-			-	-
4. Connecticut	48	88	58	146			-	146
5. Florida	43		68	68(d)		10	10	78
6. Illinois	23	20	3	23			-	31(j)
7. Massachusetts	31	262	30(d)	292			-	292
8. Michigan	441(b)			-			-	210(g)
9. Minnesota	38	94	6(f)	100	13		13	113
10. Minnesota	48		38	38			-	38
11. New Jersey	376			400(g)	25	20	45	445
12. New York	94			160(g)		88(h)	88	248
13. Pennsylvania	394	145	24	169			-	169
14. South Carolina	84(c)			-			-	-
15. Tennessee	38			34(e)			-	34
16. Utah	32			-			-	-
17. Vermont	73			125(f)			-	125
	1,785							
TOTAL		614	360	1,693	791	118	909	2,820

NOTE: The table and its parenthetical qualifications are discussed on the following page.

Discussion of Table A

The majority of wells listed in the table were contaminated by toxic substances; see the individual State report summaries for details. The following explanations and qualifications are found in Table A:

(a) There are no specific case numbers for either California entry because of the duplicative information contained in the reports furnished.

(b) Known cases only; suspected cases for 1982 are excluded.

(c) Groundwater is specifically mentioned; whether a drinking water source was also involved (i.e., a well) is not known.

(d) Public water supplies or systems, not private wells.

(e) No distinction made between private and public or other wells.

(f) Public wells or wellfields.

(g) Private wells and/or public wells and wellfields.

(h) Of these, 36 were listed as closed in 1980.

(i) Assumed to be private rather than public or industrial; another 22 groundwater locations were also contaminated, and apparently did not affect a water supply.

(j) Includes 8 industrial wells.

A summary of the Federal data contained in the digest was not attempted as it was for the State data as presented in Table A. It would have been difficult to control the double counting effect in the Federal reports, many of which have incorporated data from earlier studies and surveys.

It is important to reiterate a few caveats about the data presented in the table. First, the reports [indexes~~, lists,~~ studies] the data was drawn from are presented without the benefit of any follow-up to confirm the status of individual incidents, except to clarify general information and confirm interpretations. Second, extreme caution should be exercised in generalizing about the data set and its content. As a sample, these report summaries are incomplete and not intended to be statistically representative.

It is obvious from reading the table and its accompanying qualifications, that the information imparted is rather incomplete. For example, the New York, New Jersey, Vermont and Tennessee reports provided only gross estimates which often do not distinguish between private, public or industrial wells, and in the case of public supplies, wellfields. In Michigan's case, only 210 wells or wellfields were identified as affected, despite having 441 known cases of groundwater contamination. In 1982 there were also 456 "suspected" cases of groundwater contamination reported.

A conservative approach was taken in tabulating the numerical data, and every effort was made to avoid any double counting. In the table and in the report we have tried to list discrete incidents of contamination separately. The cases listed in the "All Cases" column are not necessarily synonymous with the number of incidents. As a category, "cases" is a general measure of incidence. There can be included within it, more individual incidents. An example from the Federal reports is the listing from EPA's Region One office. It lists 107 cases, and yet 124 separate incidents are shown; some cases include more than one discrete incident.

-xxx-

The numbers in the table do not represent the actual number or types of wells contaminated in any of the States listed, i.e., the existing situation. The data is indicative of the complexity surrounding the collection of information. The table's figures do represent the data contained in the summaries, based on our reading and analysis of the individual reports. The actual number of wells involved is unknown and a probably greater number.

Problem Resolution

Depending upon the type of contaminant involved, most State and local government entities have a limited number of options open to them in managing groundwater contamination problems. Apparently, the most frequently utilized methods of resolving the problem include the following: closing or abandoning the water supply, developing new and deeper wells, installing an aeration or filtration system, temporary use of bottled water, and the purchase of water from a neighboring community.

The use of bottled water may not always be a "safer" solution. For example, of 110 brands of bottled water tested by the Suffolk County Health Department in New York, 11 [10%] violated Safe Drinking Water Standards for chemical quality, 46 [42%] contained trace organics [compared to 18% of public supplies in the city], and 9 [8%] exceeded standards for sodium, barium, arsenic, chlorides and sulphates.[4]

---

[4] "The Groundwater Newsletter," Water Information Center, Inc., Vol. 11, No. 8, April 30, 1982.

Many officials say that the only reasonable options for dealing with groundwater contamination are: control of potential contaminants at the source, and treatment of groundwater before use. The former involves problems of how to do it and regulatory burdens etc., and the latter is typically very expensive. For example, the replacement cost for 10,000 pounds of granular activated carbon [GAC] of the type used in a filtration system can reach $32,000. In many cases replacement can occur as frequently as once a month, an annual cost of $384,000. This expense can prove burdensome for a small town or municipality with a serious contamination problem.

Conclusion

A key issue in the public policy debate over the contamination of groundwater by toxic and hazardous materials concerns the quantity and quality of the information available. This information is critical to an informed assessment of the extent and severity of groundwater contamination and in the evaluation of options for the resolution of this problem.

A large and unknown amount of contamination has already entered the groundwater system, which will continue to appear for many years into the future, regardless of present and future regulatory actions. The complexity of managing groundwater contamination is constantly changing as we learn more about groundwater recharge, complex geology, the health effects of synthetic organic chemicals, land disposal of wastes, and the geochemical behavior of contaminants in groundwater. To further complicate matters, over 1,000 new chemicals are added annually to 55,000 already active in U.S. commerce and industry.

The absence of a comprehensive data base, one predicated on systematic data collection and protocols, is a continuing problem. Because the States are developing independent data bases to support groundwater management policies, data continues to be variable and incompatible.

One cause for the development of these incompatible data systems is the lack of a standardized Federal system. Such a system would be one that other researchers and data collectors could use as a model. It could also serve an important pedagogical function. As a source of technical information on water quality and geology, comparisons between general and specific incidents could be made. It would also provide information important in developing our understanding of the chemical and physical characteristics of the groundwater dynamic.

Groundwater contamination and its concomitant effect on drinking water is not an isolated phenomenon. Every State in the country has reported instances of well closings. Furthermore, it is possible that potential cases of drinking water sources contaminated by toxic substances are not being investigated for two reasons.

One reason is the confusion and ambiguity experienced by local officials. They are without clear guidance about what level of contamination justifies regulatory action. A second reason is that most remedial alternatives and methods are prohibitively expensive. The alternative chosen is primarily dependent on the severity of the contamination, the action level used, the nature of the toxic material(s), and the community's ability to pay.

Contamination of groundwater is a gross measure of loss. In addition to the natural resources lost, losses of other kinds certainly result: the unknown and feared long-term effect on human health, economic opportunity losses, the replacement cost of a private or public water supply, a decrease in or absolute loss of property value, and the economic loss of local or regional comparative advantage, to name a few.

The emotional and intellectual fear, mistrust, and ambiguity arising from having to live with a contaminated water supply influence all of the above outcomes. Reports on groundwater contamination seldom make any effort to quantify dollar or other costs associated with this problem.

Despite the progress made since 1980 by Federal, State and local governments in identifying, inventorying, and assessing the sources and incidence of groundwater contamination, systematic data collection and standardized protocols are still infrequent. This conclusion is reflected by the Digest's content.

* * *

Digest Organization

The Digest is divided into three parts: Federal Sources, State Sources, and Institutional and Commercial Sources of information. For easier reference the Digest's 17 tables are numbered serially without respect to the report's individual parts.

The Federal part is the only one with three distinct sections: EPA, USGS, and CEQ. It contains 20 summaries of reports and studies which are numbered serially within each section; 17 from EPA, 2 from USGS, 1 from CEQ. The EPA reports are generally arranged in reverse chronological order i.e., the most recent first. Certain EPA documents in DRAFT form may not be readily available because of on-going peer and internal reviews.

The 17 State report summaries are presented in alphabetical order and are numbered serially. These reports were the only ones which could be located during the preparation of this Digest. Three States have more than one report summary: California, Connecticut, and Minnesota. There are also summaries for one institutional study and three commercial information sources.

The issuance of Federal, State and other reports on this subject is occurring more rapidly as public and private interest in groundwater quality increases. The most recent Federal report included in the Digest is EPA's "Occurrence of Organic Chemicals in Drinking Water, Air and Food," January 1983; the most recent State report included in the Digest is Michigan's "Assessment of Groundwater Contamination: Inventory of Sites," July 1982.

PART ONE: FEDERAL SOURCES

Section One: U.S. Environmental Protection Agency [EPA] 2

Section Two: U.S. Geological Survey [USGS] 34

Section Three: Council on Environmental Quality [CEQ] 39

Section One: U.S. Environmental Protection Agency [EPA]

1. DRINKING WATER SUPPLIES CONTAMINATED BY ORGANIC CHEMICALS IN NEW ENGLAND ... 3
2. OCCURRENCE OF ORGANIC CHEMICALS IN DRINKING WATER, AIR AND FOOD 7
3. ASSESSMENT OF HAZARDOUS WASTE MISMANAGEMENT: DAMAGE CASE HISTORIES 9
4. SURFACE IMPOUNDMENT ASSESSMENT: NATIONAL REPORT, and SURFACE IMPOUNDMENTS AND THEIR EFFECTS ON GROUND-WATER QUALITY IN THE UNITED STATES: A PRELIMINARY SURVEY 12
5. INSTITUTIONAL RESPONSES TO CONTAMINATION OF GROUND WATER USED FOR PUBLIC WATER SUPPLIES 16
6. COMPENDIUM OF CASES OF GROUND WATER CONTAMINATION 19
7. NATIONAL GROUND WATER SUPPLY SURVEY [GWSS] 21
8. DAMAGES AND THREATS CAUSED BY HAZARDOUS MATERIAL SITES 24
9. THE REPORT TO CONGRESS: WASTE DISPOSAL PRACTICES AND THEIR EFFECTS ON GROUND WATER 26
10. GROUNDWATER POLLUTION PROBLEMS IN THE SOUTHEASTERN UNITED STATES 28
11. GROUND-WATER POLLUTION PROBLEMS IN THE NORTHWESTERN STATES 29
12. GROUND WATER CONTAMINATION IN THE NORTHEAST STATES 29
13. GROUND WATER POLLUTION IN THE SOUTH CENTRAL STATES 30
14. GROUND WATER POLLUTION IN ARIZONA, CALIFORNIA, NEVADA, UTAH 31
15. NATIONAL STATISTICAL ASSESSMENT OF RURAL WATER CONDITIONS, and RURAL WATER SURVEY [RWS] 32
16. COMMUNITY WATER SUPPLY SURVEY [CWSS] 32
17. IDENTIFICATION OF ORGANIC COMPOUNDS IN EFFLUENTS FROM INDUSTRIAL SOURCES ... 33

The following telephone numbers may be useful to the reader wishing to obtain additional information about these EPA reports:

CONGRESSIONAL LIASON: 382-5200
EPA LOCATOR: 382-2090

U. S. ENVIRONMENTAL PROTECTION AGENCY

1. "DRINKING WATER SUPPLIES CONTAMINATED BY ORGANIC CHEMICALS IN NEW ENGLAND"
   Published: 7 March 1983 [21 pages]
   Office of Water Supply, Region I

SYNOPSIS:

This listing is periodically updated and provides information exclusively on drinking water wells known to be contaminated by organic chemicals in the New England States. Also included on the last page is a fairly complete listing of New England State contacts for information on groundwater contamination. The report identifies at least 490 drinking water wells closed and affected by groundwater contamination [see Table 2].

A more accurate assessment of the number of wells involved is difficult since most cases simply listed "wells" in the plural. The earlier February 7th listing showed that at least 335 drinking water wells were either closed or affected; 231 private, 87 public, and 17 industrial wells. The report lists the States alphabetically, and divides the information into the following four headings:

1. Location: Towns are listed alphabetically within the State.
2. Source Contaminated: All cases involve drinking water wells; the solution employed is often mentioned.
3. Primary Contaminants: The chemical(s) found are named.
4. Probable Source of Contamination

The data shown in Tables 1, 2, 3, and 4 were extrapolated from this EPA report. This information does not appear in this form in the original list unless otherwise noted. Some cases had more than one discrete contamination incident, which is why the 107 cases listed represent a total of 124 discrete incidents. This report does not show the chemical levels measured in the samples taken. The earlier report of February 7th had included measured chemical levels; they were deleted because the samples had been taken at one point in time, and were considered subject to misinterpretation. See Table 3 for information on chemicals known to be present in water samples.

Table 1: Profile of the Probable Sources of Contamination

	SOURCES						
State	Unknown	Gasoline	Dumping*	Landfill	Industrial**	Other	Total
Connecticut	8	7	1	5	21	3	45
Maine	1	2	-	1	1	-	5
Massachusetts	6	4	7	3	10	3	33
New Hampshire	4	-	-	6	2	2	14
Rhode Island	2	1	-	3	7	1	14
Vermont	2	3	-	2	2	4	13
Total	23	17	8	20	43	13(a)	124
Percent of 124	[19]	[14]	[6]	[16]	[35]	[10]	[100]

* Illegal Dumping

** Industrial Dumping; Improper Handling and Storage.

(a) Seven cases involved the disposal/use of solvents in septic systems.

Table 2: Drinking Water Wells Closed or Affected; by State

	DRINKING WATER WELLS*							
	Private		Public		Industrial		Total	
State	Closed/Affected		Closed/Affected		Closed/Affected		Closed&Affected	
Connecticut	189	4	20	20	23	2	232/26	258
Maine	24	-	-	-	-	-	24/-	24
Massachusetts	57	-	28	4	3	1	88/ 5	93
New Hampshire	20	5	3	-	-	-	23/ 5	28
Rhode Island	55	-	5	-	-	-	60/-	60
Vermont	24	-	1	1	-	1	25/ 2	27
Total	369	9	57	25	26	4	452/38	490
	378		82		30			

* A more accurate count is difficult since many cases simply listed "wells" in the plural, and did not identify the type of well involved.

In Table 2, the Connecticut listing included a number of private wells which are in fact what EPA terms a non-community public supply. The wells listed served the following small communities: mobile home parks, condominiums, industrial parks, high schools, hospitals, apartment buildings, and military bases; these wells were specifically mentioned in at least eight incidents.

In Lunenburg, Massachusetts, 200 private and 2 public wells were considered "threatened", when 2,000 barrels of industrial waste which had been dumped into a pit contaminated the water with benzene; these wells are not included in Table 2. Benzene is a component of gasoline which persists for about 20 years.

Table 3: Distribution of Chemicals Identified in Drinking Water Samples

	NUMBER OF CHEMICALS IDENTIFIED IN SAMPLES							
State	1	2	3	4	5	6	7	Total
Connecticut	17	10	11	3	3	1	-	45
Maine	3	-	1	1	-	-	-	5
Massachusetts	15	9	5	2	1	-	1	33
New Hampshire	3	5	2	3	-	-	1	14
Rhode Island	1	2	3	2	6	-	-	14
Vermont	12	-	-	1	-	-	-	13
Total	51	26	22	12	10	1	2	124 *
Percentage of 124	[41]	[21]	[18]	[10]	[8]	[1]	[1]	[100]

* A total of 124 incidents of contamination.

Table 4 shows the frequency with which certain synthetic organic chemicals appear in these water samples. Five chemicals appear to be quite common: trichloroethylene [TCE], 1,1,1-trichloroethane, tetrachloroethylene [PCE], benzene [gasoline component], toluene, and gasoline and petroleum products. The highest recorded chemical level in the February 7th report was that of butane recorded at 16,000 ppb. The second highest level was for benzene and ethylene chloride at 8,000 ppb.

Table 4: Frequency of Chemicals in the 124 Incidents/Water Samples

Chemical	Number of Times Identified
Trichloroethylene [TCE]	60
1,1,1-Trichloroethane	45
Tetrachloroethylene [PCE]	42
Benzene	21
Toluene	12
Gasoline	10
Xylene	8
1,2-Dichloroethylene	8
Chloroform	7
1,1-Dichloroethane	6
Methylene Chloride	5
1,1-Dichloroethylene	4
Other [range 1-4 chemicals]	53
Total	281

The information compiled in this EPA listing was provided to the regional office by State offices via telephone. This updated list was more specific than earlier lists as to the type and number of wells affected and closed.

SOURCE: David Chin, Environmental Engineer
Technical Assistance Section
Office of Water Supply, Region I
U.S. Environmental Protection Agency
Boston, Massachusetts 02203
(617) 223-4600

U.S. ENVIRONMENTAL PROTECTION AGENCY

2. "OCCURRENCE OF ORGANIC CHEMICALS IN DRINKING WATER, AIR AND FOOD"
Published: January 1983 [completed in 1982]

SYNOPSIS:

This report summarizes information on trichloroethylene [TCE] in drinking water; it is one in a series of studies on the presence of 13 volatile organic chemicals [VOC] in drinking water. It was conducted in support of EPA's anticipated rulemaking for limiting human exposure to certain of these VOCs [Federal Register/Vol.47, No.43, p.9350/Thursday, March 4, 1982]. This evaluation type of study was based on data previously gathered by four Federal surveys*, which are listed below:

1. NATIONAL ORGANICS MONITORING SURVEY [NOMS]
   Conducted in three phases between March 1976 and January 1977.
   18 drinking (ground) water systems were assessed.
2. NATIONAL SCREENING PROGRAM FOR ORGANICS IN DRINKING WATER [NSP]
   Conducted between June 1977 and March 1981.
   13 drinking (ground) water systems were assessed.
3. COMMUNITY WATER SUPPLY SURVEY [CWSS]
   Conducted in 1978.
   316 drinking (ground) water systems were assessed.
4. GROUNDWATER SUPPLY SURVEY [GWSS]
   Completed in 1982.
   945 public drinking (ground) water systems were assessed.

Trichloroethylene is a clear, nonflammable liquid with a vaporous odor, used as a cleaning and degreasing agent. Inadvertent production of the chemical can occur through the chlorination of drinking water and wastewater. The report found that "...a clear relationship was seen [to exist] between groundwater system size and the likelihood of trichloroethylene contamination."

In making its national projection estimates the report finds that "About 97% of groundwater systems of all sizes are expected to contain trichloroethylene at less than 0.5 micrograms per liter [ug/l]." The summary also notes that "All exposure to trichloroethylene in drinking water at levels above 5 ug/l is projected to be from groundwater sources."

---

* Some surveys included surface and groundwater; only the latter are discussed here.

The thirteen chemicals evaluated in the study series were:

1.	Trichloroethylene	TCE
2.	Tetrachloroethylene	PCE
3.	Carbon Tetrachloride	CTC
4.	Benzene	
5.	1,2,4-Trichlorobenzene	
6.	1,1,1-Trichloroethane	
7.	1,2-Dichloroethane	
8.	1,1-Dichloroethylene	
9.	1,2-Dichloroethylene	
10.	Vinyl Chloride	
11.	Chlorobenzene	
12.	Methylene Chloride	
13.	Dichlorobenzene (o,m,p)	DCB

This first report, for Trichloroethylene [TCE], was completed on 24 August 1982. The remaining 12 reports were completed and delivered to EPA in February, 1983, and were not available for inclusion in the Digest.

SOURCE: Science and Technology Branch
Criteria and Standards Division
Office of Drinking Water
U. S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460
(202) 382-3022

U.S. ENVIRONMENTAL PROTECTION AGENCY

3. "ASSESSMENT OF HAZARDOUS WASTE MISMANAGEMENT: DAMAGE CASE HISTORIES"
Published: December 1982 [DRAFT]
Wayne Tusa, Project Director
Office of Solid Waste

SYNOPSIS:

The study, done by Fred C. Hart Associates of New York, began in January 1981 and data collection was completed in June 1981. The study was designed to assess, using the available data bases, the types of damages that could be expected to occur from mismanaging hazardous wastes. The cause and effect relationship between wastes and damages at any individual site will be analyzed further in the second phase [now on-going] of the study. The principal agency objectives in conducting the study were to collect information that might be of use in the regulation setting process, and in the further development of reasonable agency expectations when investigating a given site.

The sites were selected by identifying, from all available EPA regional files, every instance of well documented damage involving the storage or disposal of hazardous wastes. A total of 929 sites from all ten regions were found to meet the criteria; storage sites outnumbered disposal sites. The results of the study were summarized nationally and by region.

A "Summary of Evaluated Sites [Table A]", contains information on the levels of "Contamination and Damage Documented (D) and Suspected (S)" for each reported incident by EPA region and is divided into six headings:

1. Site [Site Name]
2. I.D. [Damage Case Number]
3. Facility Type [14 categories]
4. Contamination Media [4 categories]
5. Damage Affected Area [5 categories]
6. Severity [2 categories: tri-level rating; high, medium, low]

For the purpose of analyzing the report's "Table A", we divided the data into the following four categories of contamination:

Category	Condition
One:	Documented/Groundwater and Drinking Water
Two:	Documented/Groundwater and Suspected/Drinking Water
Three:	Documented/Groundwater
Four:	Suspected/Groundwater and Suspected or Documented/Drinking Water

The results are shown below:

Table 5: CRS Analysis of "Table A: Summary of Evaluated Sites"

EPA Region	CATEGORY						
	One	Two	Three	Four	Total	Other *	All Incidents
1	10	7	11	9	37	4	41
2	24	20	34	86	164	51	215
3	40	12	20	69	141	23	164
4	13	17	17	42	89	62	151
5	5	2	-	46	53	64	117
6	16	11	11	34	72	25	97
7	8	11	2	16	37	24	61
8	-	2	3	10	15	10	25
9	6	1	4	9	20	24	44
10	4	4	12	6	26	11	37
Total	126	87	114	327	654	298	952
Percentage of 952	[13]	[9]	[12]	[34]	[69]	[31]	

* These cases fall outside the four established categories.

NOTE: According to EPA, the variance between the total of 952 incidents and the 929 sites/incidents is accounted for by a minor double counting of 23 cases in the original "Table A."

The field investigation team [FIT] reports, which average 10-15 pages, have more detailed information concerning each site and damage case. The study attempts to profile the damage case characteristics, such as the chemical(s) involved, remedial response initiated or employed, and the facility type. The association between cause and effect will be investigated in the second phase of the study.

The report also surveyed the 929 sites for information concerning their operating age. Only 354 facilities [38%] were documented well enough to analyze. The average operating age of all 354 facilities was 7.6 years; the high and low were 95 and less than five years, respectively. Approximately 234 facilities had been in operation for between one and 38 years, and 18 for more than 57 years.

SOURCE: Office of Solid Waste
U.S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460
(202) 382-4667

U. S. ENVIRONMENTAL PROTECTION AGENCY

4. "SURFACE IMPOUNDMENT ASSESSMENT: NATIONAL REPORT" [DRAFT-180 pages], and "SURFACE IMPOUNDMENTS AND THEIR EFFECTS ON GROUND-WATER QUALITY IN THE UNITED STATES - A PRELIMINARY SURVEY" [275 pages]
Published: December 1982, and 1978, respectively.
Office of Drinking Water

SYNOPSIS:

This nationwide survey was conducted as a one time only inventory and hydrogeologic evaluation of the groundwater pollution potential of impoundments. The report is based on individual assessments in which all States, Guam, Puerto Rico], and the Pacific Trust Territories, participated. As a "desktop" study there was little or no independent verification by EPA concerning the information provided in the individual State reports. The National Report and Preliminary Survey were authorized under Section 1442(b)(3)(c) and (a)(8)(c), of the Safe Drinking Water Act [SDWA] [Public Law 93-523].

Approximately $5 Million in grants was made available to the States for conducting the surface impoundment assessments [SIA]. The assessment's intent as summarized in the 1978 survey was to "...provide broad background information on the use of municipal, industrial, and agricultural surface impoundments ... and the potential threats they may pose to the quality of underground drinking water resources and to methods of controlling or abating such threats." Surface impoundments were classified into five types; Municipal, Industrial, Oil & Gas, Mining, and Agriculture. The draft of the 1982 National Report has not yet been released pending an internal EPA review.

National Report 1982

All numbers in the National Report are approximations. The States mainly used secondary sources of data. The National Report located a total of 180,973 impoundments, and of these 38,089 or 21% were assessed. A total of 80,263 impoundment sites were located and of these 31,386 or 39% were assessed. Many facilities had more than one impoundment. About 50% or 16,000 of the assessed sites had impoundments located over "...unsaturated geologic zones that afford little protection to groundwater supplies."

The National Report also found that:

- Brine disposal pits accounted for 65,000 or 36.0% of all impoundments
- Municipal impoundments accounted for 37,185 or 20.5% of all impoundments
- Industrial impoundments accounted for 27,912 or 15.4% of all impoundments.

The report also found that "...most state programs, whether they address facility standards and direct discharges or whether they are empowered to permit indirect discharges, are not adequately staffed and funded to provide the comprehensive plan reviews, regular inspections, effective monitoring programs, and consistent, timely enforcement actions required to assure compliance with permit conditions."

The assessment also includes "...selected case-history data on groundwater contamination." Chapter VI contains a total of 416 case studies of groundwater contamination from surface impoundments that were discussed in some detail in the State reports. The data is considered illustrative rather than comprehensive. Another 143 specific cases were reported but not included in the analysis because of insufficient information.

Seven States - Alaska, Georgia, Hawaii, Louisiana, Mississippi, New Hampshire, and Wyoming - provided no case studies at all. The 416 case studies are distributed among the remaining states; the following have 12 or more: New Mexico-52, North Carolina-28, South Carolina-28, Wisconsin-24, Michigan-21, Texas-17, Massachusetts-14, Illinois-13, Florida-12, and California-12. The remaining 33 States included between one and 11 case studies, for an average of 5.6 cases per State.

Of the 416 case studies, approximately 75 and 80 cases were from Municipal and Industrial [SIC 28 Chemical and Allied Products] sources, respectively. Mining was next with 40 cases. Seepage was the leading cause of contamination in 79% of the cases, as might be expected from the purpose of the report.

"The vast majority of states indicated that surface impoundments have already polluted groundwater, and that the potential for further contamination is high." "...Just under 45% of the cases were not discovered until they had adversely affected water quality in supply wells..." ; "...One case caused more than 50 domestic wells to be closed ... and 12% of the cases caused injury to either crops, wildlife, livestock or surface water." "Less than 30% of the industrial impoundments are lined and fewer are lined in other categories."

Table 6: Surface Impoundment Summary

Class	NUMBER Located	Assessed [%]
Sites or Facilities	80,263	31,386 [39]
Impoundments	180,973	38,089 [21]

NOTE: Many Sites or Facilities had more than one impoundment.

Preliminary Survey 1978

The 1978 summary said that "...few detailed studies of groundwater threats have been made largely because few water wells are known to have been adversely affected by them [surface impoundments], and also because..." such studies are difficult and costly. The EPA also acknowledged that a wide variety of organic and inorganic materials have entered the groundwater. This conclusion was based on the "...records of selected case histories of contamination [that are available] in 29 states."

A summary [Table 8] in the preliminary survey listed 85 case histories. In 79 cases groundwater was degraded, and in 12 of the 79 cases a loss of the drinking water supply - i.e., a municipal wellfield(s), private well(s), and springs - is specifically mentioned. EPA said that "...incidents of groundwater contamination from surface impoundments have been reported in nearly all states." The reader was cautioned that these cases were not intended to delineate the magnitude of the problem in any way.

However, EPA acknowledged that the "...aquisition and review of the records of the hundreds of past and recent case histories [of groundwater contamination], which are believed to be in State and EPA files, would have required an expenditure of time and funds beyond the scope of this study."

One of the most complete SIA's was submitted by the State of Pennsylvania's Department of Environmental Resources, Bureau of Water Quality Management. Its report [215 pages] includes much important information about the State's groundwater resource. Below is a sampling of information available in its Tables and Figures:

A. Ratings of the potential for groundwater contamination by total assessed impoundments.
B. Ratings of the potential for groundwater contamination by assessed, active industrial impoundments with documented groundwater contamination.
C. Impoundments causing confirmed or suspected groundwater contamination.
D. Probability of aquifer contamination based on SIA groundwater contamination potential rating.
E. Occurrence of liners in active, industrial impoundments with documented groundwater contamination.
F. Groundwater contamination potential of selected pollution cases.

SOURCE: State Programs Division
Office of Drinking Water
U. S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

U.S. ENVIRONMENTAL PROTECTION AGENCY

5. "INSTITUTIONAL RESPONSES TO CONTAMINATION OF GROUND WATER USED FOR PUBLIC WATER SUPPLIES: Implications for EPA R&D Programs"
Published: 30 November 1982 [208 pages]
Strategic and Scientific Assessment Staff [SSA]

SYNOPSIS:

This report was prepared by ICF, Incorporated of Washington, D.C. The report was originally entitled "Assessment of Trends in Ground Water Contamination." Its stated intention was to "...provide insights about the common problems and research needs of states and municipalities [in] dealing with groundwater contamination...." The report is organized into five sections: methodology, analysis of cases, research and development needs, appendices, and conclusions. The complete case studies are included in an appendix along with a list of State contacts.

The report focuses mainly on the patterns of contamination and the responses of the associated institutions. Initially, the authors surveyed a group of 77 case studies, from which a final set of 15 were chosen for in-depth investigation. An analysis of these 77 cases revealed numerous instances of contaminated wells.

Table 7: Contaminated Drinking Water Wells; 77 Cases

	STATUS		
WELLS	Affected	Closed	Total
Private	846	170	1,016
Public	215	145	360
Total	1,061	315	1,376

A total of 1,376 private and public drinking water wells were either closed or affected. Those shown above include only those instances in which specific numbers of wells by type are provided. The data as presented in the survey implies that many more wells were involved.

In the final study group of 15 cases investigated, seven were analyzed through on-site visits and eight using telephone interviews. At least 52 municipal wells have been closed and eight affected. Another 280 private water wells were also identified as having been affected. The cases came from seven of the ten EPA regions.

In New Brighton, Minnesota, an estimated 18 square miles of groundwater is contaminated. On average, 49% of the public water supplies were affected in these 15 cases, and the nearly unanimous agency response was to condemn the affected wells. Leaking underground storage tanks containing organic solvents and gasoline were involved to some degree in one third of these cases.

The report makes several findings. One finding was a lack of unambiguous guidelines on the risk level and health effects of toxic organic chemicals in drinking water. The lack of such guidance affected agencies concerned with drinking water quality in two critical ways:

First, agencies had to choose the "correct" risk level when at least four were available; the National Academy of Science [NAS] level, the EPA's Suggested No Adverse Response Level [SNARL], the Maximum Contaminant Level [MCL], and in many cases one, two or more different State risk levels.

Second, in designing a water treatment system which employs an aeration technology, the desired quality of finished water is dependent upon the action level chosen for a single or particular group of contaminants; typically synthetic and low molecular weight [volatile] organic chemicals [VOCs].

The report also found that trichloroethylene [TCE] contamination is widespread. This chemical, most often used in drycleaning and as a degreasing agent, was a contaminant in 80% of the 15 cases. Levels of TCE as high as 13,000 and 5,700 [ppb] parts per billion, were measured in public well water.

The report summarizes [Table III-3] State guidelines for TCE in drinking water. It reveals a wide variety of risk levels, from 0.00 ppb in Vero Beach, Florida, to 75 ppb in Massachusetts and Pennsylvania. Washington State has no guideline and manages on a case-by-case basis.

The report also notes an interesting observation concerning the practice of pumping contaminated groundwater from a well into a nearby stream or river, in an effort to control the movement of contaminated groundwater. This may exacerbate the problem by drawing the contaminated water into another well's cone of influence, or increasing the plume's "normal" rate of migration, or both.

SOURCE: Strategic and Scientific Assessment Staff
Office of Research and Development
U.S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

U. S. ENVIRONMENTAL PROTECTION AGENCY

6. "COMPENDIUM OF CASES OF GROUND WATER CONTAMINATION"
Published: 26 August 1982 [140 pages]
Carl Kessler, Operations Research Analyst
Economic and Policy Analysis Branch

SYNOPSIS:

This report was prepared for the use of the Groundwater Policy Group of EPA to assist them in formulating an agency groundwater strategy. Except for a brief introductory discussion of the problem, this report is largely comprised of four appendices. According to the report "...Anecdotal information provides many insights into the nature, extent and consequences of groundwater contamination...."

The first appendix contains all of chapter six from the New Mexico Surface Impoundment Assessment [SIA/1980]. Approximately 110 cases involving groundwater contamination from surface impoundments and other facilities are discussed briefly. The report lists only the more serious incidents affecting relatively large areas, and says "Incidents of localized groundwater contamination ... are too numerous to include...." Local problems are shown by county via short individual case descriptions.

The second appendix is an excerpt from a 1961 HEW groundwater symposia proceedings which contain illustrative cases of groundwater contamination. A total of 11 cases from Ohio, Minnesota, Long Island, New York, Washington, Michigan, Kentucky, Colorado, and Illinois are discussed in detail.

The third appendix contains 18 brief examples of contamination case studies which appear in government studies: from the States of California, Colorado, Maine, Illinois, Massachusetts, Michigan, Minnesota, Ohio, New Jersey, North Carolina, Pennsylvania, and Tennessee.

The fourth appendix is a bibliography containing 61 references. The earliest is from 1951 and concerns the contamination of underground water by chromium wastes. The most recent case is from the Environmental Assessment Council of the Academy of Natural Sciences of Philadelphia's 1982 draft report on groundwater contamination (see Part III, Digest summary #1).

While the report says, "From the wealth of anecdotes we may conclude that contamination is widespread and that many cases are serious enough to warrant the closure of the water supply," it also cautions that this collection of case studies "...cannot be combined into a quantitative description of the state of groundwater degradation in the U.S. Such a synthesis will have to be done judgmentally."

SOURCE: Economic and Policy Analysis Branch
Office of Drinking Water (WH-550)
U. S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

U. S. ENVIRONMENTAL PROTECTION AGENCY

7. "NATIONAL GROUND WATER SUPPLY SURVEY" [GWSS]

Published: June 1982

James J. Westrick, J. Wayne Mello, Robert F. Thomas

Technical Support Division

SYNOPSIS:

The survey conducted a sampling and analysis program on finished water from 945 public water supply systems which depend on groundwater sources. It was designed to satisfy two objectives:

First, to "...provide additional data useful for the estimation of the nationwide occurrence of volatile organic chemicals [VOCs] in drinking water supplied from underground sources."

Second, to "...stimulate the interest and involvement of state drinking water agencies in seeking out problems of contamination of groundwater supplies and in examining potential solutions to those problems."

Underlying these objectives was the need for information that could contribute to the possible development of regulatory options for limiting VOCs in drinking water. The 945 systems were divided into a random group of 466 supplies, and a nonrandom group of 479 supplies.

The random sample included 466 supplies, geographically distributed, comprised of 181 large system supplies serving more than 10,000 people, and 285 small system supplies serving less than 10,000 people. This sample was drawn from the Federal Reporting Data System's [FRDS] inventory of public water systems.

Preliminary results from the random sample show that 16.5% of small systems had at least one VOC above its quantitation level and that 28.7% of large systems contained measureable levels of VOCs. Thirty of the 466 supplies were contaminated with TCE alone, at concentrations ranging from .24 to 78 ug/l. And, 21 of these were large systems, serving populations of more than 10,000 people. In this random sample the percentage of large systems contaminated by VOCs was significantly greater than that of small systems.

The nonrandom sample included 479 supplies, geographically distributed, and was selected by State agencies. The States were encouraged to choose supplies for which no prior VOC data was available and which had a higher than normal probability of contamination by VOCs. At the higher levels of contamination the percentage of "hits" were two to four times greater in the State selected nonrandom sample, than in the random sample.

Preliminary results from the nonrandom sample show a higher frequency of contamination at all levels for large (36%) and small (30%) systems. Sixty-one of the 479 supplies were contaminated with TCE alone, at concentrations of between .20 and 130 ug/l. Of these, 38 were large systems serving a population of more than 10,000 people. The average level of TCE alone for both the random and nonrandom samples was between 8 and 9 ug/l. According to the report "Many of the VOCs are adverse to human health in some measure and some ... are known or suspected carcinogens."

The following six chemicals occurred most frequently in survey samples:

1. Trichloroethylene [TCE]
2. 1,1,1-Trichloroethane
3. Tetrachloroethylene [PCE]
4. cic/trans-1,2-Dichloroethylene
5. 1,1-Dichloroethane
6. Carbon Tetrachloride [CTC]

Table 8: GWSS Data Summary of Public Water Supply Systems

Sample Type	Total Systems		% of Systems w/VOCs		Number of Systems w/TCE *	
Random	466		45.2		30	
Large Systems		181		28.7		21
Small Systems		285		16.5		9
Nonrandom	479		66.0		61	
Large Systems		155		36.0		38
Small Systems		324		30.0		23
Total	945				91	

* Other VOCs were found but only data for TCE is shown here; TCE is widely regarded as a "benchmark" VOC, indicating the potential for other VOCs being present.

NOTE: The TCE data shown in this summary was taken from the EPA report entitled "OCCURRENCE OF ORGANIC CHEMICALS IN DRINKING WATER, AIR AND FOOD," (see EPA Digest summary #2).

SOURCE: Technical Support Division
Office of Drinking Water
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

U. S. ENVIRONMENTAL PROTECTION AGENCY

8. "DAMAGES AND THREATS CAUSED BY HAZARDOUS MATERIAL SITES"

Published: February 1980 [DRAFT/175 pages]

Oil and Special Materials Control Division

SYNOPSIS:

This report lists 244 hazardous material incidents from 41 States. It was released in a slightly different form, by Representative Toby Moffett [D-Conn], Chairman of the House Government Operations Subcommittee on Environment, Energy and Natural Resources, in September of 1980. The sites are listed by EPA Region, and by State within each region. The report stresses that it is an initial effort and therefore an incomplete listing of damages to the public health and environment. About 122 of these cases specifically mention groundwater contamination by hazardous or toxic materials. The report classifies the full range of organic and inorganic wastes into six loosely divided categories:

1. Solvents and Related Organics [TCE, Toluene]
2. PCB's and PBB's
3. Pesticides
4. Inorganic Chemicals [Ammonia, Cyanide, Acids]
5. Heavy Metals [Chromium, Lead, Mercury]
6. Waste Oils and Grease

The first part of the report provides detailed information on 24 hazardous material incidents in 16 States. At least 334 drinking water wells were closed, and another 49 affected. Also, at least four municipal groundwater supplies were affected. The total cost of remedying these 15 cases alone was estimated to be between $200 and $416 million, some of it already spent.

The second part of the report [which includes 8 cases from Part I] provides less information on about 220 hazardous material incidents in 41 States. At least 871 drinking water wells were closed, and another 288 affected. Two communities, Acton and Bedford, Massachusetts lost 45% and 85%, respectively of their water supplies because of contaminated groundwater. At least 18 municipal wells or well-fields were identified as affected. The total cost of remedying 107 of these 220 cases is estimated to be between $380 and $442 million, some of it already spent. In nearly all cases, the groundwater resource was abandoned with virtually no remedial or corrective measures undertaken.

A summary of those incidents involving drinking [ground] water, the number of wells by type, the number of States by section, and the estimated costs are shown below:

Table 9: Summary of Groundwater Contamination Incidents(a)

			DRINKING	WATER	WELLS	COSTS(d)
	States	Incidents(b)	Closed	Affected(c)	Total	High-Low
Section I	16	24/ 15	334	49	4	200-416
Section II	41	220/107	871	288	18	380-442
	Total	244/122	1205	337	22	580-858

(a) A minor double counting effect exists because a few cases are listed in both sections.

(b) Total incidents/incidents with groundwater contamination specifically mentioned.

(c) In Section I only 4 Public wells were identified, in Section II only 18 Public wells were identified.

(d) Estimated/in Millions

NOTE: All wells mentioned in the report are presumed to be private, except (c).

SOURCE: Oil and Special Materials Control Division (WH-548)
Office of Water and Waste Management
U. S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

U.S. ENVIRONMENTAL PROTECTION AGENCY

9. "THE REPORT TO CONGRESS: WASTE DISPOSAL PRACTICES AND THEIR EFFECTS ON GROUND WATER"
Published: January 1977 [513 pages]
Office of Water Supply

SYNOPSIS:

In January 1977 EPA issued this report to Congress on "Waste Disposal Practices and Their Effects on Ground Water." It is in two parts, an "Executive Summary" of 45 pages, and a "Report" of 513 pages. The report contains data arranged into 84 figures and 80 tables. Funded under Section 1442(a)(4) of the Safe Drinking Water Act [SDWA], it was conducted by Geraghty & Miller, Inc., of Syosset, New York. It is also available in paperback from Premier Press of Berkeley, California; published in 1980.

This report is a comprehensive guide, for the layman and expert alike, to understanding groundwater resource issues. The report's findings are reported unabridged in the executive summary. Issues concerning groundwaters of the U.S. are explored thoroughly. The characteristics of groundwater use, availability, geographic extent, the population served, source and supply in 1970, and how waste disposal practices affect it, are examined. The hydrogeologic groundwater system, aquifer classifications and descriptions, water use by households and industry, and growth projections of waste quantities by type and industry are also included. Case histories of groundwater contamination are presented and summarized.

Selected findings from the report follow:

- "A national strategy of groundwater protection will require a better understanding of the environmental, legal, technical, and economic complexities of dealing with the resource."
- "Waste disposal practices have affected the safety and availability of groundwater, but the overall usefulness has not been diminished on a national basis."
- "Because clean-up of contaminated groundwater is rarely economically or technically feasible, action by the states has been directed toward condemning the affected water supply."

- "Almost every known instance of groundwater contamination has been discovered only after a drinking water source has been affected."
- "Few state or local agencies systematically collect data on contamination incidents, water supply wells affected, and drinking water supplies condemned as unsafe."
- "There are potentially millions of sources of contamination and isolated bodies of groundwater contamination nationwide."
- "The opportunity for severe contamination of groundwater is greatest from industrial waste-water impoundments and sites for land disposal of solid wastes."
- "Serious local economic problems have occurred because of the loss of groundwater supplies."
- "The contamination of an aquifer can rule out its usefulness as a drinking water source for decades and possibly centuries."

Of 57 groundwater contamination case histories, 13 cases involved the chemical industry, and 9 cases involved the metal processing and plating industry. The other 35 instances were distributed among 18 different industries or activities.

Of 42 cases involving municipal landfills, five had contaminated groundwater with toxic substances, which resulted in the abandonment of 76 drinking water wells [71 residential, 4 industry, and 1 public]. There was no litigation involved in four of the five cases, and remedial costs [in 1977] had amounted to $2,803,084. Two of the cases had been concluded for a combined cost of $232,204. Costs in the two continuing cases had amounted to $2,570,880.

Of 18 industrial landfill cases, 14 involved pollution by toxic substances. As a result, the pumping capacity of 3 industrial and 8 public supply wells has been reduced in an attempt to control the level of contamination.

SOURCE: Office of Solid Waste Management Programs
Office of Water Supply
U. S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

The following five [10-14] EPA regional reports were conducted between 1971 and 1977, and include a broad range of information concerning groundwater resource problems. Thirty-three (33) States were investigated in the five reports listed here. The themes quoted from the reports are common throughout the series, with some variation for regional emphases.

The format of these reports usually includes: a description of the project area, the natural quality of groundwater, the conditions causing pollution of groundwater, pollution indicators by basin within each State, major aquifer system descriptions, and areas of needed research. Recent reports are listed first.

Ecological Research Series

10. "GROUNDWATER POLLUTION PROBLEMS IN THE SOUTHEASTERN UNITED STATES"
EPA-600/3-77-022, January 1977 [361 pages]
By: J.C. Miller, P.S. Hackenberry, F.A. DeLuca
States(7): Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, and Virginia.

The abstract notes:

- "The findings of the investigation indicate that the cases of groundwater contamination recorded to date and referenced in this report represent only a very small percentage of those that actually exist."

The report concludes:

- "Surface impoundments, which are used for treating, handling, and storing liquid wastes and sludges, are leaking many millions of litres per year of potentially hazardous substances to groundwater."
- "As reported by well drillers, petroleum products in groundwater supplies is the most common reason for well replacement because of contamination."
- "As reported by well drillers in the region, bacterial contamination by septic tanks is the second most common reason for well replacement."

11. "GROUND-WATER POLLUTION PROBLEMS IN THE NORTHWESTERN STATES"
EPA-660/3 5-018, May 1975 [360 pages]
By: Frits van der Leeden, L.A. Cerrillo, and D.W. Miller
States(6): Colorado, Idaho, Montana, Oregon, Washington, and Wyoming.

The abstract notes:

- "...Few cases of groundwater pollution have been investigated in detail. There is a need for baseline water-quality data and systematic evaluation of overall groundwater conditions, especially in urban zones...."

The report concludes:

- "The most significant source of groundwater contamination is the discharge of sewage from septic tank systems."
- "Surface impoundments used to treat, handle, or store liquid wastes and sludges are leaking large quantities of contaminants to groundwater."
- "Cases of groundwater contamination by gasoline spills or leaks have been documented in all six states."

Environmental Protection Technology Series

12. "GROUND WATER CONTAMINATION IN THE NORTHEAST STATES"
EPA-660/2-74-056, June 1974 [326 pages]
Office of Research and Development
By: D.W. Miller, F.A. DeLuca, and T.L. Tessier
States(11): Massachusetts, Vermont, Maine, New Hampshire, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, and Delaware.

A summary of data on 42 municipal and 18 industrial landfill contamination cases is included in Table 36. Tables 37 and 39 provide information on the causes and pollutants involved in a total of 93 cases.

The abstract notes:

- "...The hundreds of cases of groundwater contamination recorded to date and referenced in this report represent only a very small percentage of those that actually exist."
- "Basic research is needed on how to improve methods to inventory and correct problems of groundwater contamination and how to prevent future problems through better management and control of activities that can affect groundwater quality."

The report concludes:

- "Buried storage tanks and pipelines ... are significant sources of groundwater contamination ... the most troublesome pollutants from this source are hydrocarbons and industrial wastes containing toxic substances."
- "Only a very small percentage of the instances of groundwater contamination from all sources that probably exist in the region have been discovered to date. Of the more than one thousand cases inventoried in this investigation, almost all were reported only after a water supply well or spring had been noticeably affected or the pollutant was being discharged to the surface...."

13. "GROUND WATER POLLUTION IN THE SOUTH CENTRAL STATES"
EPA-R2-73-268, June 1973 [182 pages]
By: M.R. Scalf, J.W. Keeley, and C.J. LaFevers
States: (5) Arkansas, Louisiana, New Mexico, Oklahoma, Texas.

The report concludes:

- "Because of the critical shortage of water resources in the western half of the project area, any contamination of fresh water has an immediate and long lasting effect."
- "Pollution from oil-field brines is the most serious form of ... pollution..."
- "Care must be exercised in locating ... disposal or treatment areas [for solid and liquid wastes] so as to prevent contamination of groundwater by known or unknown leachates."
- "There has been little work done concerning groundwater pollution by organics, metals, bacteria and viruses. Consequently, the true pollutional potential of many of man's activities cannot be fully evaluated."

Water Pollution Control Series

14. "GROUND WATER POLLUTION IN ARIZONA, CALIFORNIA, NEVADA, UTAH"
EPA-16060 ERU, December 1971 [251 pages]
Office of Research and Monitoring
By: Dean K. Fuhriman and James R. Barton

This report says that future research and investigation should focus on pollution problems specifically related to solid wastes, waste disposal injection wells, land disposal of wastes, aquifer interchange, and groundwater pollution identification. The large scale pollution of Los Angeles' groundwater in 1968 caused by a 250,000 gallon gasoline pipeline leak, is considered "long-term" and "disastrous."

The report concludes:

- "It is impossible to adequately consider problems of groundwater quality without also considering groundwater quantity."
- "Phenols, gasoline and similar products have been found in the groundwater at a few locations, and represent a constant hazard because of their widespread use."

SOURCE: Office of Drinking Water
U. S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

The following two EPA reports [15 & 16] were summarized from other reports and supplemented with information gathered by telephone.

15. "NATIONAL STATISTICAL ASSESSMENT OF RURAL WATER CONDITIONS" [DRAFT], and
"RURAL WATER SURVEY" [RWS] Published: 1983

SYNOPSIS:

The Rural Water Survey [1978-1982] presents the field information upon which the Final Report of the National Statistical Assessment of Rural Water Conditions is based. The latter is a broad based statistical study evaluating compliance with national primary and secondary drinking water standards. The study was conducted under Section 3 of the SDWA which requires that EPA test for quality and quantity conditions.

The study sample was composed of 2,654 households in 400 counties from the 48 contiguous States. The most recent analyses of households served by public water supplies was utilized whenever possible. The water was tested for quality at the tap, not at the source, although the source is identified in the report. It found that "...perhaps the greatest protection for the continuing quality of water from non-community water systems would be the preservation of groundwater quality...." The Final Report is now being reviewed and is scheduled to be available by June 1983. The four volume report summary was prepared by Cornell University.

16. "COMMUNITY WATER SUPPLY SURVEY" [CWSS] Published: 1978

SYNOPSIS:

This report provides information on community water supplies from around the country. From an initial group of 781 drinking water systems, 452 drinking water systems were selected for analysis; 330 were groundwater systems, and 106 were surface water systems. They were selected randomly within categories stratified to be representative of geographic regions and system sizes. The study tested for trihalomethanes and a selected group of 11 volatile organic chemicals.

SOURCE: Office of Drinking Water
U. S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

U.S. ENVIRONMENTAL PROTECTION AGENCY

17. "IDENTIFICATION OF ORGANIC COMPOUNDS IN EFFLUENTS FROM INDUSTRIAL SOURCES"
Published: April 1975 [Final Report: EPA-560/3-75-002] [248 pages]
SYNOPSIS:

This report contains useful information on organic chemicals, their reactions in water and air, chemical classifications, and biodegradability. Among other conclusions reached in the summary are:

- "...That the discharge of treated or untreated industrial waterborne effluents is the most obvious industrial contribution to the presence of organics in drinking water."

- "...Industrially related compounds may reach drinking water supplies through groundwater contamination...."

- "...Chemical interactions may also occur during soil and groundwater migration forming other organic compounds potentially destined for surface waters...."

It also acknowledges that "...general consumer use of industrial products is a major though much less obvious source of contamination...."

SOURCE: Office of Toxic Substances
U. S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

Section Two: U.S. Geological Survey [USGS]

1. USGS PUBLICATIONS CONCERNING GROUND-WATER CONTAMINATION INCIDENTS 35
2. NATIONAL WATER DATA EXCHANGE [NAWDEX] 36

U.S. GEOLOGICAL SURVEY

1. "USGS PUBLICATIONS CONCERNING GROUND-WATER CONTAMINATION INCIDENTS"
   Published: 1982 [17 pages]
   Office of Hazardous Waste Hydrology

SYNOPSIS:

This bibliography lists 191 citations, compiled from the very extensive USGS series of professional papers and reports. It was prepared by the USGS in response to a request for information on groundwater contaminated by hazardous wastes. The four principal series used in this bibliography are:

1. Professional Paper Series [PP]: Begun in 1900, its primary subject area is geology. Less than 10% of the more than 2,000 titles contain information specific to water resources.
2. Water Supply Paper Series [WSP]: Contains more than 2,000 titles and is primarily concerned with surface water. Twenty new titles are added yearly.
3. Water Resources Investigation Series [WRI]: Approximately 350 titles have been added since the series' inception in 1975. Until August 1982, these papers had been available from the National Technical Information System [NTIS]. At that time they were transferred to the Open File Services Section of the USGS in Denver, Colorado.
4. Open File Reports Series [OFR]: Available from Open-File Services. This file contains over 8,500 titles compiled from every USGS department since 1975. Approximately one third are from the USGS Water Resources Division.

Many of these reports can be obtained from the:

Open-File Services Section
Western Distribution Branch
U.S. Geological Survey
Box 25425, Federal Center
Lakewood, Colorado 80225
(303) 234-5888

SOURCE: Office of Hazardous Waste Hydrology
United States Geological Survey
410 National Center
Reston, Virginia 22092
(703) 860-6976

U.S. GEOLOGICAL SURVEY

2. "NATIONAL WATER DATA EXCHANGE [NAWDEX]"

Water Resources Division

SYNOPSIS:

The NAWDEX is a national confederation of water oriented organizations with voluntary membership. The USGS Office of Water Data Coordination manages water data as prescribed in OMB Circular A-67 of 1964. There are 60 Local Assistance Centers in 45 States and Puerto Rico, and a current Directory is available free.

A primary objective of the NAWDEX is to improve access to water data and to help users identify, locate and acquire needed data; it is not itself a repository of water data. Development of NAWDEX began in January 1973 and the system became operational in January 1976. The NAWDEX Program Office has four major areas of operation:

A. An Internal Data Center.
B. Indexing water data held by participating organizations.
C. Responding to requests for water data.
D. Formulating recommendations for water data handling and exchange standards.

At the present time there are over 400 member organizations and new ones are added on a continuing basis. When used in conjunction, the Master Water Data Index and the Water Data Sources Directory can locate information on surface water and groundwater for a specific geographic area.

	Document Title	Open-File Number
A.	Master Water Data Index	82-327
B.	Water Data Sources Directory	82-923
C.	Directory of [NAWDEX] Member Organizations	82-902
D.	Directory of Assistance Centers	82-925

These indexes and directories can be obtained from the:

Open-File Services Section
Western Distribution Branch
U.S. Geological Survey
Box 25425, Federal Center
Lakewood, Colorado 80225
(303) 234-5888

Other Federal and State data base systems are also accessible through NAWDEX:

Federal Systems

1. WATSTORE: Water Data Storage and Retrieval System
   U.S. Geological Survey [USGS]
2. STORET: Storage and Retrieval System
   U.S. Environmental Protection Agency [EPA]
3. EDS: Environment Data Service
   National Oceanic and Atmospheric Administration [NOAA]
4. ENDEX: Environmental Data Index
   National Oceanic and Atmospheric Administration [NOAA]
5. WRSIC: Water Resources Scientific Information Center
   U.S. Department of the Interior/Office of Water Research & Technology
6. WATDOC: Water Resources Document
   Reference Center of the Inland Waters Directorate
   Canadian Department of Fisheries and Environment

State Systems

* 1. TNRIS: Texas Natural Resources Information System
   Texas Department of Water Resources
* 2. IWARDS: Iowa Water Resources Data System
   Iowa Geological Survey
3. WARDS: Water Resources Data System
   Pennsylvania Department of Environmental Resources
4. REAP: Regional Environment Assessment Program
   North Dakota Resource Reference System
* 5. NNRIS: Nebraska Natural Resources Information System
   Nebraska Natural Resources Commission

* Serve as NAWDEX Assistance Centers

SOURCE: National Water Data Exchange
NAWDEX Program Office
Water Resources Division
U. S. Geological Survey
421 National Center
Reston, Virginia 22092
(703) 860-6031
FTS 928-6031

Section Three: Council On Environmental Quality [CEQ]

1. CONTAMINATION OF GROUND WATER BY TOXIC ORGANIC CHEMICALS 40

COUNCIL ON ENVIRONMENTAL QUALITY

1. "CONTAMINATION OF GROUND WATER BY TOXIC ORGANIC CHEMICALS"

Published: January 1981 [84 pages]

SYNOPSIS:

This report is divided into three chapters: 1. Groundwater Characteristics and Contamination, 2. Contamination of Drinking Water Wells, and 3. The Health Risks of Toxic Organic Chemicals. CEQ's Table 5 is a compilation of organic compounds found in groundwater, as reported by 18 states. The report includes seven brief incident descriptions of what are now celebrated instances of groundwater contamination.

Chapter two contains a section which analyzes the condition of and trends in groundwater contamination; the analysis is based on information available from EPA and State surveys, and the CEQ's own survey. CEQ's Table 8 shows "Toxic Organic Compounds found in Drinking Water Wells." Thirty-three chemicals and their concentrations in ppb are listed by State, and compared to the highest reported national surface water concentration. Concentrations in groundwater exceeded those of surface water for 30 of the 33 chemicals listed.

Table 10: Chemical Concentrations Measured in Surface Water versus Groundwater

		HIGHEST CONCENTRATIONS REPORTED IN THE U.S.		
	Chemical	Groundwater	/ State	Surface Water
1.	Trichloroethylene [TCE]	27,300 ppb	PA	
		14,000 ppb	PA	160.0 ppb
		3,800 ppb	NY	
2.	Toluene	6,400 ppb	NJ	6.1 ppb
3.	Chloroform	490 ppb	NY	700.0 ppb
4.	Methylene Chloride	3,000 ppb	NJ	13.0 ppb
5.	1,1,1-Trichloroethane	5,440 ppb	ME	5.1 ppb
6.	Tetrachloroethylene [PCE]	1,500 ppb	NJ	21.0 ppb

"The CEQ has determined that hundreds of drinking water wells affecting the domestic water of millions of people have been closed in the last three years because of contamination by toxic organic chemicals."

SOURCE: Executive Office of The President
Gus Speth, Chairman
Council On Environmental Quality
722 Jackson Place, N.W.
Washington, D.C. 20006

PART TWO: STATE SOURCES

1. CALIFORNIA
[DHS] REPORTS CONTAINING GROUNDWATER CONTAMINATION INFORMATION 43
2. CALIFORNIA
[SWRCB] REPORTS CONTAINING GROUNDWATER CONTAMINATION INFORMATION 46
3. CONNECTICUT
ANNUAL OIL AND CHEMICAL SPILL SUMMARY FOR FY 1981-1982 48
4. CONNECTICUT
SUPPLIES WHICH HAVE EXCEEDED THE SNARLs* FOR ORGANICS 49
5. FLORIDA
FLORIDA GROUND WATER CONTAMINATION SITES 50
6. ILLINOIS
GROUND-WATER CONTAMINATION: PROBLEMS AND REMEDIAL ACTIONS 52
7. MASSACHUSETTS
CHEMICAL CONTAMINATION 53
8. MICHIGAN
ASSESSMENT OF GROUNDWATER CONTAMINATION: INVENTORY OF SITES 54
9. MINNESOTA
HAZARDOUS WASTE LOG 55
10. MINNESOTA
VOLATILE ORGANICS SAMPLING 56
11. NEW JERSEY
GROUND WATER POLLUTION INDEX 58
12. NEW YORK
ORGANIC CHEMICALS AND DRINKING WATER 59
13. PENNSYLVANIA
WATER QUALITY INVENTORY, 1982 60

14. SOUTH CAROLINA
INVENTORY OF KNOWN GROUND-WATER CONTAMINATION CASES AND GENERALIZED DELINEATION OF FIVE GROUND-WATER RECHARGE AREAS IN SOUTH CAROLINA 64
15. TENNESSEE
PROFILE OF EXISTING GROUNDWATER PROBLEMS IN TENNESSEE 65
16. UTAH
A SURVEY AND EVALUATION OF SHALLOW GROUNDWATER CONTAMINATION HAZARDS IN THE STATE OF UTAH 67
17. VERMONT
VERMONT UNDERGROUND INJECTION PRACTICES AND GROUNDWATER CONTAMINATION INCIDENTS SURVEY 68

NOTE: The State data contained in the Digest's summaries are shown in Table A on page xxiii of the Discussion section.

1. CALIFORNIA: "[DHS] REPORTS CONTAINING GROUNDWATER CONTAMINATION INFORMATION"

SYNOPSIS:

In February 1983, the Department of Health Services provided CRS with information on groundwater contamination by organic chemicals and pesticides. The title and a brief description of each report is provided below:

A. "Dibromochloropropane [DBCP] in Drinking Water" [1982] Letter & Attachments

DBCP is a nematocide that was used in California from about 1959 until 1977 when it was banned. Early data from the DHS's DBCP sampling program, which is based on 7,000 groundwater samples, indicates that 750 wells had DBCP in excess of the 1 ppb action level*. More information should be made available soon.

B. "Memorandum Report On The Status Of Groundwater Contamination In The San Gabriel Valley [Los Angeles]" [April 1982]

This memorandum reports on a Spring 1982 investigation and the status of domestic water supply wells in the San Gabriel Valley. Twenty-five public water systems, serving a population of 4,565,336, were sampled at 351 well locations. Of the 25 public water systems, 12 must serve water with an organic chemical in excess of an action level sometime during the year; 109 wells were found to have some level of contamination. The report does not make clear how many people may be affected by the contaminated well water.

C. "Purgeable Organics in Four Groundwater Basins" [1981?]
Stephen Nelson, Safi Kalifa, and Frank Baumann

This survey analyzes "...Public water system wells in four groundwater basins...." Two of the basins were contaminated with organic chemicals. The contamination usually occurred in discrete areas with trichloroethylene [TCE] and tetrachloroethylene [PCE] present in all samples with volatile organic compounds [VOC], except one. Seven "purgeable organics" were tested for: TCE, PCE, CCl, 1,1,1-trichloroethane, benzene, ethyl benzene, and toluene. In the main San Gabriel Basin, 82 wells were sampled, 36 of them for purgeable organics. Sixteen of these had from one to five chemicals present. Thirty-two wells were contaminated by TCE and PCE.

* The "Action Level" is the concentration above which the State DHS recommends that water not be used for human consumption.

In the Bunker Hill Basin, 138 wells were sampled, 24 of them for purgeable organics. Twenty-four of the 138 wells had contamination involving TCE and PCE, which were the only VOCs found, and six of the 24 wells had one or two chemicals present. Contamination levels were lower than those in the San Gabriel Basin. In both basins the contamination sites were generally near and downgradient from major industrial areas.

D. "Summary of DOHS Monitoring for DD and Telone" [1981, 1982, 1983]

DD and Telone are organic chemicals used as agricultural [soil] fumigants. The active ingredient in both is dichloropropane and dichloropropene. Telone is a mixture of 1,2-dichloropropane and 1,3-dochloropropane. The State has been monitoring for these chemicals since 1981 in areas of heaviest use. The State survey found five wells, out of 64 sites sampled for 36 VOCs, at a level of .05 ppb or more, to be contaminated.

In the Del Norte County community of Smith River, three private wells were found to have measured levels of 1,2-dichloropropane at 28 ppb, 30.5 ppb, and 4.6 ppb respectively. Preliminary results indicate that six square miles and 60 separate homes may be affected. The flower bulb growing industry is predominant in the area. Associated with this site are two monitoring wells which sample water from beneath a chemical drum disposal site. More than 1,500 empty drums, which once contained pesticides used in the area, are believed responsible for contamination of the groundwater. High levels of PCE, 1,2-dichloropropane, 2,4,-D, and 2,4,5-T [from .030 ppm to 1,200 ppb] have been measured in the water. The area water table rises to within one foot of the surface in the winter and drops to ten feet during the summer.

Table 11: California Action Levels * for Selected Chemicals

TCE	or trichloroethylene	5 ppb**
PCE	or tetrachloroethylene	4 ppb
CTC	or carbon tetrachloride	5 ppb
DD	or dichloropropane-dichloropropene	10 ppb
DBCP	or dibromochloropropane	1 ppb

* The "Action Level" is the concentration above which the State DHS recommends that water not be used for human consumption.

** ppb = parts per billion.

SOURCE: David Spath
Sanitary Engineering Branch
Environmental Health Division
California Department of Health Services
2151 Berkeley Way
Berkeley, California 94704
(415) 540-2172

2. CALIFORNIA: "[SWRCB] REPORTS CONTAINING GROUNDWATER CONTAMINATION INFORMATION"

SYNOPSIS:

In February 1983, the State Water Resources Control Board [SWRCB] provided CRS with information on groundwater contamination by organic chemicals and pesticides. The title and a brief description of each report is provided below:

A. "Fact Sheet on 1,2-dichloropropane [1,2-DCP]" [6 pages]

Issued by the North Coast Regional Office of the SWRCB; preliminary findings revealed 1,2-dichloropropane in the drinking water wells of the Smith River Plains area of Del Norte County.

B. "Polychlorinated Biphenyls (PCB)" [Draft, 200 pages]

Issued by the SWRCB's Industrial Chemicals Unit of the Toxic Substances Control Program. Groundwater will be tested for 12 toxic chemicals. No results were contained in the material received by CRS.

C. "Fact Sheet on Finding 1,2-DCP in San Joaquin County Well Water" [2 pages]

The National Toxicology Program is presently assessing the carcinogenicity of this chemical. Twenty-five percent of wells in San Joaquin County tested positive for 1,2-DCP [DD] a pesticide, at the action level of 10 ppb.

The State Water Resources Control Board [SWRCB], the Department of Water Resources [DWR], and the Department of Health Services [DHS], under the terms of a Memorandum of Understanding [MOU] (due to expire in July 1983) are cooperating in a Toxic Pollutant Problem Identification and Migration Study. This study will investigate groundwater "hot spots" for toxic substances. The objective is to detect problems caused by the use of soil fumigants and other chlorinated organic compounds early enough to prevent serious damage. Of particular concern are 1,2-dichloropropane [DD], and to a lesser extent CDB, which have replaced DBCP as the soil fumigant of choice in California. Between 1977, when DBCP was banned, and 1981, the use of DD quadrupled from 4 million pounds/year to 16 million pounds/year.

The DHS administers the provisions of the Safe Drinking Water Act [SDWA] while their counterparts at SWRCB administer the provisions of the Clean Water Act [CWA]. The SWRCB is also responsible for preventing the pollution of groundwater and the issuance of clean-up orders.

In the Toxic Pollutant Migration Study's background section the authors find that "Contamination of groundwater is exceedingly difficult, if not impossible, to clean-up after the fact. Most technology for decontamination of groundwater is poor. Prevention is the key." And, in a telephone conversation Dr. Cohen said that "There should be a strong national policy on this [groundwater pollution] issue...."

The Santa Clara County Intergovernmental Council in San Jose is considering a model ordinance that will regulate the storage and handling of hazardous materials. The ordinance was initially drafted by "...the County Fire Chief's Association in response to incidents of leakage of hazardous materials into the underground water table that have occurred throughout the county."

* The "Action Level" is the concentration above which the State DHS recommends that water not be used for human consumption.

SOURCE: David Cohen, Program Manager
Toxic Substances Control Program
Office of Special Projects
State Water Resources Control Board
P.O. Box 100
Sacremento, California 95801
(916) 322-8401

3. CONNECTICUT: "ANNUAL OIL and CHEMICAL SPILL SUMMARY for FY 1981-1982"
Published: 13 September 1982 [Fiscal-Year-End Report]
Department of Environmental Protection [42 pages]

SYNOPSIS:

This report is a computer generated listing of oil and chemical spills from the Hazardous Material Automated Management System. It shows that spills reported in fiscal 1982 increased by 319 cases to 1,326 incidents, from the 1,007 incidents reported in 1981. The format is divided into nine headings:

1. Date
2. Town
3. Water Body Affected
4. Discharger
5. Substance
6. Cause
7. Corrective Action
8. Total-Volume
9. Total-in-water

Contamination of groundwater is specifically mentioned in 45 cases. The majority involve the presence of gasoline [24 cases], fuel oil/waste oil or kerosene [21 cases]. These incidents were almost exclusively the result of the failing of inground storage tanks and pipelines.

SOURCE: Hazardous Materials Management Unit
Oil and Chemicals Spills Section
Connecticut Department of Environmental Protection
State Office Building
Hartford, Connecticut 06115
(203) 566-4686/4633

4. CONNECTICUT: "SUPPLIES WHICH HAVE EXCEEDED THE SNARLs* FOR ORGANICS"

Published: July 1981 [updated semi-annually]

Connecticut Department of Health Services [11 pages]

SYNOPSIS:

This report lists 48 cases of drinking [ground] water supplies contaminated with organic chemicals in excess of SNARLs. At least 58 public or factory and 88 private drinking water wells have been affected. Most cases resulted from abandoned landfills, gasoline station inground storage tank leaks, dry cleaning activity, the improper handling of industrial wastes, and illegal dumping. Fifteen cases were classified as active, and 27 as resolved. Resolution usually means that bottled water or a connection to municipal water has been substituted for the contaminated well water.

Cases are listed alphabetically by town within State regions, and the reporting format is divided into eight headings:

1. Town/Region
2. Source
3. Substance
4. ug/l concentration
5. Date
6. Type of Sample
7. Potential source of pollution and comments. [short description]
8. Status

* SNARL: Suggested No Adverse Response Level (EPA)

SOURCE: Water Supply Section
Division of Preventable Diseases
Connecticut Department of Health Services
79 Elm Street
Hartford, Connecticut 06115

5. FLORIDA: "FLORIDA GROUND WATER CONTAMINATION SITES"
Published: 26 August 1982 [31 pages]
Department of Environmental Regulation

SYNOPSIS:

This inventory contains 43 cases found in 19 counties. Paragraph-long descriptions accompany each case. The principal cause of contamination appears to be unlined disposal pits, ponds, and lagoons used for solid and liquid industrial waste disposal. At least ten wells in municipal wellfields were closed. The Biscayne Aquifer is shown to be contaminated from at least three sources by heavy metals [chromium], plus DDT and DDD, and other synthetic organic chemicals.

Case Examples

- In 1957 an unlined disposal pit used by a fertilizer manufacturer for 68 years was abandoned. A nearby municipal well was abandoned in 1958 because of chemical contamination. When sampled again in 1975, the well water still had such high levels of contamination that the well remains abandoned.

- The Preston-Hialeah wellfield, Miami's principal drinking water source and a part of the Biscayne Aquifer, is contaminated with some organic and inorganic constituents.

- In 1977, 15 volatile organic compounds were detected in the East Drive wellfield which supplies the City of North Miami Beach with its drinking water. And, in 1972, at Miami International Airport, an estimated one million gallons of petroleum distillate solvent leaked from a ruptured underground pipeline before being discovered. According to a Miami News report which appeared in the August 5, 1982 edition, the city is planning to abandon the entire well-field and switch to county water by 1984.

Also included in the report is a list of drinking water supply wells with excessive levels of volatile organic compounds as determined by the U.S. EPA's National Ground Water Supply Survey of 1981. Twenty water supplies, serving a population of approximately 685,000 persons, were contaminated with from one to seven synthetic organic compounds. Another 48 public supply systems had total organic compounds [TOC] present at some level and require further testing to determine the specific type of chemical(s) present.

A "Profile of State Agencies' Activities Affecting Groundwater Quality in Florida" [September 1981, 18 pages], is also available from this office. The 17 categories [eg. groundwater monitoring, spill prevention and control, waste disposal and storage, well plugging, injection wells, etc.] are each subdivided into four headings:

1. Activity Impacting Groundwater Quality
2. Agency
3. Existing Legislation
4. Activity Profile

SOURCE: Groundwater Section
Florida Department of Environmental Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32301-8241
(904) 488-3601

6. ILLINOIS: "GROUND-WATER CONTAMINATION: PROBLEMS AND REMEDIAL ACTIONS"

Published: May 1977 [58 pages]
David E. Lindorff and Keros Cartwright
Illinois State Geological Survey

SYNOPSIS:

The report contains detailed information on 116 groundwater contamination case histories from 27 States and 6 Canadian provinces. Twenty-three groundwater contamination cases from Illinois are included, and show that at least 31 public, private and industrial drinking water wells were affected. A range of topics are discussed in the report such as, the factors which affect remedial actions and their effectiveness. It also explores a variety of strategies for managing groundwater pollution emergencies, some based on those used by other States.

In collecting information on how other states manage groundwater emergencies, the authors queried 49 States and 9 Canadian provinces. Twenty-seven States and six Canadian provinces responded. Among the most significant of conclusions according to the report, was "...that no formal strategies have been developed specifically for groundwater pollution emergencies." And, "...case histories indicate that remedial action for groundwater and earth contamination is usually complex, time consuming, and expensive." They also found that "...only about one-third of the responses stated or implied that [the] ... technical expertise [necessary in managing groundwater contamination] is available in state government."

A toxic substance was involved in 97 of the 116 cases and their distribution by type of contaminant is shown below:

A. 18 cases of gasoline & petroleum products in 8 states.
B. 31 cases of leachate contamination in 13 states.
C. 31 cases of industrial wastes * contamination in 15 states.
D. 9 cases of organic and chemical wastes in 6 states.
E. 4 cases of pesticide contamination in 3 states.
F. 4 miscellaneous cases of toxic contamination in 4 states.

* Includes: plating wastes, acids, vinyl cyanide, heavy metals.

SOURCE: Environmental Geology Notes #81
Illinois State Geological Survey
Urbana, Illinois 61801

7. MASSACHUSETTS: "CHEMICAL CONTAMINATION"
Published: October 1981 [Revised from 1979]
Lee Dane and Staff [88 pages]
Special Legislative Commission on Water Supply

SYNOPSIS:

This report details 31 cases of groundwater contamination which has affected at least 30 public water supply systems and over 262 private wells. Two pages of descriptive text with sections on the history, response, and effects are provided for each case. In addition to these cases, another 95 communities are identified as having had their water contaminated by tetrachloroethylene [PCE], which leached from the vinyl lining of water main and distribution system piping. According to the report an estimated 23 million [daily yield] gallons of water have been rendered unusable for drinking water purposes because of chemical pollution.

Among other conclusions, the report states, "...Long range planning and comprehensive management of both water supply aquifers and all potentially hazardous materials will be the only economically feasible and environmentally effective approach to protecting our water resources."

SOURCE: Special Legislative Commission on Water Supply (SLCWS)
Commonwealth of Massachusetts
Room 701
14 Beacon Street
Boston, Massachusetts 02108
(617) 722-1233

3. MICHIGAN: "ASSESSMENT OF GROUNDWATER CONTAMINATION: INVENTORY OF SITES"

Published: July 1982 [242 pages]
Department of Natural Resources [Update of 1979 Report]

SYNOPSIS:

The report is an attempt to list all identified sites where groundwater is or may be contaminated. A total of 897 known and suspected cases were tabulated for 1982, and a total of 649 known and suspected cases were tabulated in 1979. The report is divided into three major categories:

A. Locations where groundwaters are known to have been polluted.
B. Locations where groundwaters are suspected to have been polluted.
C. Locations where a potential exists for groundwater to become contaminated.

All three groups include maps showing the incident location by county, and the density and frequency of occurrence. In 1982 there were 441 known and 456 suspected incidents of pollution. In 1979 there were 268 known and 381 suspected incidents of pollution. It is not clear how many of the earlier (1979) incidents are included in the more recent 1982 report. All cases are shown in tabular form by:

1. Location/Name
2. Type of Facility
3. Nature of the Pollutant
4. Nature of the Source
5. Actions Needed [12 types]
6. Drinking Water Well Affected [yes/no]
7. Status of the Site [six levels]

Of the 441 known 1982 cases, public or private drinking water wells were contaminated in 210 instances. And in 66 of these 210 instances, two or more toxic* chemicals or wastes were involved. Of the 441 confirmed cases, toxic chemicals or wastes were present in 365 or 83% of the cases.

* Toxic: Heavy metals, synthetic organic chemicals, pesticides, herbicides, fungicides, and petroleum products [gasoline and fuel oil], etc.

SOURCE: Groundwater Quality Division
Groundwater Management Strategy for Michigan
Department of Natural Resources
Stevens T. Mason Building
Lansing, Michigan 48926
(517) 373-8448

9. MINNESOTA: "HAZARDOUS WASTE LOG"
Published: December 1982 [59 pages]
Pollution Control Agency

SYNOPSIS:

This log, which is updated periodically, is a compilation of contamination incidents. The December 1982 report describes 58 incidents. For each, the report contains a description approximately a page in length; each is divided into eight headings:

1. Priority [four levels: A,B,C,D]
2. Facility [generator and disposal site name]
3. Location
4. MPCA/EPA Staff
5. Problems Actual or Potential
6. Actions Taken
7. Last Action Taken
8. Actions Needed

Groundwater contamination is documented in 38 or 66% of the incidents included in the log. At least 13 private wells have been closed and 94 affected. Another 6 municipal wells or wellfields have also been affected. Most of the remaining 20 incidents are considered to pose a potential threat to continued groundwater quality. The last page identifies six "...sites at which no further remedial measures are now necessary other than continued monitoring."

SOURCE: Regulatory Compliance Section
Solid and Hazardous Waste Division
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, Minnesota 55113

10. MINNESOTA: "VOLATILE ORGANICS SAMPLING"

October 1980 through June 1982 [Community Water Supplies]
Published: June 1982 [25 pages]
Department of Health

SYNOPSIS:

There are 998 community water supplies, serving 3.2 million people, and 10,973 non-community public water supplies in the State. Since October of 1980, the Department of Health has been sampling municipal water wells in the vicinity of active and inactive waste disposal and spill sites. Within two years the department expects to sample 2,000 municipal wells, 50% of those in the State, for halogenated and non-halogenated volatile organics. Of 156 wells sampled in 57 locations to date, 38 have shown some level of contamination. At least 19 wells have been ordered out of service.

This index is divided into five headings:

1. Municipality [sampling location]
2. Well Formation and Depth
3. Sampling Date
4. Laboratory Completion Date [for each sample]
5. Results [in ug/l]

In this index there are 48 cases* involving approximately 117 sampled wells. Of these, 38 wells were found to contain up to eight organic contaminants. The majority of contaminated wells had between one and three chemicals present. The remaining 79 wells sampled had no measureable levels of contamination. A maximum of 19 samples were taken from any one well over its sampling period. Although the longest sampling period was nine months, many wells were sampled over a much shorter time span.

A well in Arden Hills, sampled between June 1981 and January 1982, had the highest recorded level of contamination; 1,1,2-trichloroethylene at 570 ug/l. The well with the greatest number of chemicals [eight] present was Well #3 in New Brighton. The results show the high and low range of measured concentrations in the samples for all halogenated and non-halogenated organic chemicals.

* Surface water incident samples from the index are excluded here.

The distribution of measured chemical concentrations in the 38 wells is shown below:

1. Wells with concentrations less than	5 ug/l*	93
2. Wells with concentrations between	6 and 40 ug/l	30
3. Wells with concentrations between	41 and 100 ug/l	6
4. Wells with concentrations greater than	101 ug/l	7
	Total	136

These calculations include both the measured high and low concentrations for each chemical found in every contaminated well, over its respective sampling period. This accounts for the large number of measurements relative to the number of wells.

* ug/l = micrograms per liter.

SOURCE: Section of Water Supply and General Engineering
Minnesota Department of Health
717 S. E. Delaware Street
P. O. Box 9441
Minneapolis, Minnesota 55440
(617) 623-5000/5297

11. NEW JERSEY: "GROUND WATER POLLUTION INDEX" [1975-1981]

Published: June 1981 [56 pages]

Department of Environmental Protection

SYNOPSIS:

This report describes 376 cases involving groundwater contamination. An estimated 400 or more private and public drinking water wells are known to be contaminated. At least 20 public and 25 private wells are identified as closed. The index is divided into five classifications:

1. Accidental	(A)	pg. 1-23	164 cases
2. Illegal Dumping	(D)	pg. 24-27	24 cases
3. Industrial	(I)	pg. 28-51	157 cases
4. Sanitary Landfill	(S)	pg. 52-55	27 cases
5. Septic Tanks	(ST)	pg. 55-56	4 cases
		Total	376 cases

Each case gives the location of the incident by name [city/town/county], the date initiated [with DEP], and the type of geologic formation involved [68 are identified and abbreviated in the glossary]. Each case also has a paragraph-long description which includes the most important incident characteristics.

SOURCE: Division of Water Resources
New Jersey Department of Environmental Protection
P. O. BOX CN-029
Trenton, New Jersey 08625
(609) 292-5262

12. NEW YORK: "ORGANIC CHEMICALS AND DRINKING WATER"
Published: April 1981 [140 pages]
Nancy Kim, Ph.D. and Daniel W. Stone, P. E.
State Department of Health

SYNOPSIS:

This comprehensive report, revised from 1980, includes information on groundwater and selected cases of surface water contamination. Federal Control Procedures and State Health Department concerns are discussed. The chemical contamination of water supplies and water quality in the State is characterized, and methods for estimating relative risk are explored. The control of contamination by synthetic organic compounds in public water systems and strategies for their management is also reviewed.

The executive summary acknowledges the existence of a health risk to consumers due to synthetic chemicals in drinking water. Six distinct policy options are offered. The report also contains appendices which include information on: various Federal and State surveys on chemicals in drinking water, finished water quality in various New York locations, cost estimates for groundwater resource development, and on filtration and aeration systems.

Appendix D-1 lists "Community Water System Sources Closed by Organic Contamination; Currently Reopened 3/81." The list identifies 11 municipal systems and 17 wells that were closed and have been reopened. Currently closed are 28 municipal water systems affecting 52 wells. The contamination source in most of these cases has not been identified.

Appendix E-2 shows that "Organic Contamination of New York State Aquifers" involves 30 systems serving an estimated 314,000 people. Approximately 160 public and private drinking water wells outside Long Island, serving an estimated 25,000 people, had detectable levels of synthetic organic contaminants present. The 1980 report identified 36 public drinking water supply wells which had been closed on Long Island affecting an estimated 2.1 million people.

SOURCE: Bureau of Public Water Supply
New York State Department of Health
Empire State Plaza, Tower Building
Albany, New York 12237
(518) 474-5577

13. PENNSYLVANIA: "WATER QUALITY INVENTORY, 1982"

Published: April 1982 [318 pages]

Bureau of Water Quality Management

SYNOPSIS:

This document reports on all facets of the State water quality management program and was prepared pursuant to requirements of Section 305(b) of the Clean Water Act. It reviews current and planned programs to control surface and groundwater pollution. Some of the data used in the preparation of this report was obtained from the Comprehensive Water Quality Management Planning Program [COWAMP].

Information on known or potential problems concerning groundwater is contained in Section IV, Groundwater, and Section V, Drinking Water Supplies. Table IV-2 of the inventory lists public groundwater supplies by: COWAMP study area [there are nine], county, number of establishments, number of wells, number of springs, and total of wells and springs. The COWAMP area tables are comprised of four headings:

1. Major Groundwater Problem
2. Location [township/county]
3. Estimated Area Affected [acres/square miles]
4. Programs Underway/Proposed To Correct Problem

Of 25 municipal water authorities reportedly experiencing problems with their drinking [ground] water supplies, 12 sources were found to be contaminated by one or more toxic substances. The next most common problem appears to result from metals and acid mine drainage.

Of the 384 cases listed in Table 12, an estimate of the area affected, in acres and square miles, was made in 267 cases. No such estimate was available for the remaining 117 cases. Nearly 249 or 65% of all cases involved toxic materials. Gasoline and finished petroleum products accounted for about 176 [71%] of these cases; or 46% of all 384 cases. The data in Tables 12 and 13, which follow, was either derived or interpreted from "Section IV: Ground-Water," of the WQI Report.

13. PENNSYLVANIA: "WATER QUALITY INVENTORY, 1982"

Table 12: Groundwater Contamination Cases and Estimated Acres Affected; by COWAMP Area

COWAMP Area	CASES			ESTIMATED ACRES AFFECTED			
	Total	Toxic [%]	Non-Toxic [%]	Toxic [%]	Non-Toxic	Total	Cases [%]*
1	146	86 [59]	60 [41]	6,769 [95]	357	7,126	61 [42]
2	71	54 [76]	17 [24]	168 [68]	80	248	39 [55]
3	54	49 [91]	5 [9]	469 [90]	53	522	7 [13]
4	13	6 [46]	7 [54]	22 -	122,453	122,475(a)	- -
5	14	6 [43]	8 [57]	10 [8]	124	134	1 [7]
6	41	28 [68]	13 [32]	185 [2]	11,322	11,507	4 [10]
7	3	1 [33]	2 [67]	15 -	-	15(A*)	- -
8	24	13 [54]	11 [46]	671 -	14	685(B*)	4 [17]
9	18	6 [33]	12 [67]	2,960 [33]	6,012	8,972	1 [6]
Total	384	249 [65]	135 [35]	11,269 [7.4]	140,415	151,684	117 [31]
			In Square Miles	18	219	237	

* Area affected was undetermined in these cases [accompanied by percentage of total cases]. For example, in COWAMP Area 1, 61 of 146 [42%] cases had no estimate for the area affected.

(A*) Most of five townships and part of eleven others; caused primarily by brines and drilling fluids from oil and gas exploration.

(B*) Very extensive; involves six counties [countywide] and two other townships; caused primarily by surface and deep mining activities.

(a) Massive groundwater contamination caused by acid mine drainage due to underground coal mining.

NOTE: Percentages are based on COWAMP Area [row] totals, and may not add due to rounding. 640 acres = one square mile.

Table 13: Occurrence of Contamination Cases; by Type and COWAMP Area

Contaminant	Total	[%]	COWAMP AREA 1	2	3	4	5	6	7	8	9
1. Gasoline	101	[26.3]	31	26	27	3	-	11	-	3	-
2. Petroleum Products(a)	75	[19.5]	18	19	11	2	6	9	-	9	1
3. Organics	58	[15.1]	32 #	6	9	-	-	5	1	-	5
4. Leachate	53	[13.8]	35	9	2	-	3	2	-	2	-
5. Other	26	[6.8]	18	5	2	1	4	5	-	1	-
6. Chlorides, Sulfates & Nitrates(b)	23	[6.0]	11	2	1	2	1	3	2	-	1
7. Underground Coal Mining (c)	23	[6.0]	-	-	-	4	-	-	-	8	11
8. Metals	14	[3.7]	4	3	2	1	-	3	-	1	-
9. Sewage	11	[3.0]	7	1	-	-	-	3	-	-	-
Total Cases	384		146	71	54	13	14	41	3	24	18
Percent		[101]	[38]	[19]	[14]	[3]	[4]	[11]	[1]	[6]	[5]

# Nearly all caused by trichloroethylene [TCE].

(a) Includes fuel oil, diesel fuel, kerosene, and crude oil.

(b) Includes contamination resulting from surface mining, oil production, brines from natural gas exploration, and inorganics [nearly equal numbers of cases].

(c) Almost exclusively due to coal, oil and gas drilling activity and the resulting acid mine drainage.

NOTE: The definition of toxic used in Table 12 and 13 includes organic chemicals, gasoline, fuel oil, other petroleum products, heavy metals, and pesticides, etc. Leachate is excluded since its constituents were unknown. However, leachate often contains a wide range of toxic elements in varying concentrations. Percentages may not add due to rounding.

In the gasoline and petroleum products contamination categories the majority of cases involved the leaking of underground storage tanks and pipelines. One case, in the Cumberland County Township of Hampden, has so far recovered 212,000 gallons of gasoline from the local groundwater system.

The report identifies approximately 145 private residential and 13 municipal drinking water wells which have been affected by groundwater contamination; the majority of them by toxic contaminants. Most of the remaining wells were affected by coal mining activity, and by oil and gas drilling.

Another excellent source of information on Pennsylvania's groundwater resource is the Bureau of Water Quality Management's 1980 Surface Impoundment Assessment, [215 pages], which includes selected groundwater contamination case histories and is available from the Department of Environmental Resources [DER].

SOURCE: Bureau of Water Quality Management
Department of Environmental Resources
Commonwealth of Pennsylvania
P.O. Box 2063
Harrisburg, Pennsylvania 17120

14. SOUTH CAROLINA: "INVENTORY OF KNOWN GROUND-WATER CONTAMINATION CASES AND GENERALIZED DELINEATION OF FIVE GROUND-WATER RECHARGE AREAS IN SOUTH CAROLINA"

Published: March 1982 [120 pages]
Harriet K. Hardee and Suzanna K. McFadden
Department of Health and Environmental Control

SYNOPSIS:

Only groundwater contamination cases documented since March 1980 are included in the inventory. A total of 84 cases are included; 26 cases are described in detail with accompanying maps, and the remaining 58 cases are shown in tabular form. The major contaminants identified in these 84 cases are shown below [some had more than one contaminant; 31 of the cases involved miscellaneous pollutants such as bacteria, pesticides, nutrients, and sulfates.]:

1. Petroleum and Fuels	21 cases
2. Organics	21 cases
3. Heavy Metals	20 cases
4. Nitrates	11 cases
5. Other	11 cases
Total	84 cases

Five groundwater recharge areas are also discussed in detail. The authors contend that "...the protection of recharge zones through land-use controls should be the primary approach to maintaining the quality of ground water in significant high-quality aquifers." The complete text of a proposed "Ground-Water Quality Protection Act" is also included.

SOURCE: Bureau of Water Supply and Special Programs
Ground-Water Protection Division
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, South Carolina 29201

15. TENNESSEE: "PROFILE OF EXISTING GROUNDWATER PROBLEMS IN TENNESSEE"

Published: 2 February 1981 [Letter/6 pages]

D. Elmo Lunn, Director

Department of Public Health

SYNOPSIS:

This profile, a letter to the EPA Region V Groundwater Section office, reports on 38 contamination incidents selected to give some idea of the types of problems that have occurred in Tennessee. The profile is not presented as complete. The report notes that more information may be available from their files.

Most cases are identified by their place name, longitude and latitude. The descriptions are brief and written in an anecdotal style. At least 34 municipal, private, and monitoring wells were affected to some degree by toxics. Contaminants identified in the groundwater included: phenols, heavy metals, oils, aromatic hydrocarbons, coal tar creosote, volatile organic chemicals, radioactive industrial wastes, toluene, pesticides [heptachlor], mercury, herbicides, PCB, TCP, and gasoline.

The primary causes of contamination appear to be dumping and leaking pits, ponds and lagoons. One case involved a DuPont Chemical Company deep underground injection well used for disposing of chemical wastes. The well's casing failed at the 2,000 foot level, which led to the contamination of groundwater in the vicinity.

Three contamination incidents involved disposal of radiological wastes by private and government operated entities. In 1969, Co60 [a radioactive isotope of cobalt] was dumped into a sinkhole. When again analyzed in 1980, easily detectable levels of Co60 were still present in the water, even though the half-life of Co60 is about five years. The U.S. Department of Energy [DOE] laboratory at Oak Ridge and a Nuclear Fuels Inc. plant were also implicated in the contamination of groundwater by radiological wastes.

In geographic terms the most extensive case involved the contamination of over 1,000 acres by chlorinated hydrocarbons from the Velsicol chemical dump site in Hardeman County. Another case had at least 13 organic chemicals present in the groundwater; wells more than 1/4 mile from the source were contaminated.

Apparently, gasoline leaks from underground storage tanks and pipelines is a common problem. And, the dumping of all types of waste into sinkholes is also a seemingly convenient and frequently employed method of disposal.

SOURCE: Solid Waste Management Section
Division of Water Quality Control
Tennessee Department of Public Health
150 Ninth Avenue, N.
Nashville, Tennessee 37212

15. UTAH: "A SURVEY AND EVALUATION OF SHALLOW GROUNDWATER CONTAMINATION HAZARDS IN THE STATE OF UTAH"

Published: June 1981 [45 pages]
Edward P. Fisk and Calvin G. Clyde
Utah Water Research Laboratory

SYNOPSIS:

This report is one in a "Hydraulics and Hydrology Series" [UWRL/H-81/04], and presents instances of groundwater quality hazards at 32 sites in Utah. "A very wide range of hazards to groundwater quality were found to exist." The survey was conducted "...to appraise the current man-made contamination of shallow groundwater in Utah...."

The survey found that a widespread problem in the State involves the improper disposal of oil field brines. Leaking disposal ponds "...and poorly managed solid waste dumps are serious hazards locally...." The survey also found that although "...the state can cope with problems of shallow groundwater contamination, there is a need to extend the heavy emphasis on surface water protection to that of groundwater."

SOURCE: College of Engineering
Utah Water Research Laboratory
Utah State University
Logan, Utah 84322

17. VERMONT: "VERMONT UNDERGROUND INJECTION PRACTICES AND GROUNDWATER CONTAMINATION INCIDENTS SURVEY"

Published: 1 May 1982 [33 pages]

Agency of Environmental Conservation

SYNOPSIS:

The report is largely devoted to groundwater issues rather than injection practices. Prepared by the Marshfield Engineering Services Company, information in the report was gathered from a variety of sources. The principal sources used were: State agency files, in-person and telephone interviews with local and State officials, and a direct mail survey to various people in the groundwater field. About 30% of 1,000 questionnaires mailed were returned. Generally, respondents declined to answer if they had nothing positive to report. This was confirmed by a sample of calls made back to non-respondents.

Initially the survey identified 200 cases where the potential for groundwater contamination existed; 73 were well enough documented to report on. The use and storage of road salt accounted for the largest number of incidents. Leaking underground gasoline and fuel oil storage tanks and pipelines were the second leading cause. These two groups account for nearly 60% of incidents, with 86 water supplies contaminated; 43 drilled and 32 shallow wells, and 11 springs. Another 13 groundwater locations were also contaminated.

The report also found that 15 water supplies were contaminated either by organic chemicals [5 cases] or landfill leachate [10 cases]. Gasoline and fuel oil, landfills, and organic chemicals were involved in 33 cases, affecting 24 water supplies and 9 other groundwater locations. The report recommended that State agencies responsible for water quality expand their chemical analysis of water "...as much as possible..." to determine the extent of the problem. The report also recommended regular [hydrostatic] testing of underground storage tanks since they identified over 1,000 such tanks as potential problems.

SOURCE: Water Quality Division
Vermont Department of Water Resources and Environmental Engineering
Agency of Environmental Conservation
Montpelier, Vermont 05602

PART THREE: INSTITUTIONAL and COMMERCIAL SOURCES

1. ACADEMY OF NATURAL SCIENCES
    GROUND WATER CONTAMINATION IN THE UNITED STATES 70
2. WATER WELL JOURNAL PUBLISHING COMPANY
    ALERT 71
3. WATER INFORMATION CENTER, INC.
    THE GROUND WATER NEWSLETTER 72
4. NATIONAL GROUND WATER INFORMATION CENTER
    NATIONAL GROUND WATER INFORMATION CENTER DATA BASE 73

1. ACADEMY OF NATURAL SCIENCES: "GROUND WATER CONTAMINATION IN THE UNITED STATES"
Published: March 1983 [DRAFT]
Dr. Veronica Pye, Research Director
Jocelyn Kelley, Research Assistant

SYNOPSIS:

To date, this is probably the most comprehensive attempt to assess the extent and severity of groundwater contamination in the United States. The study was begun in August 1981, with the collection of data ending in April 1982. It is the first full scale in-house study attempted by the Council. Detailed information on ten States is provided: Arizona, California, Connecticut, Florida, Idaho, New Jersey, Illinois, Nebraska, South Carolina, and New Mexico. Some measure of information is also presented on ten other States: Georgia, Colorado, Massachusetts, Michigan, Minnesota, Montana, Rhode Island, South Dakota, Tennessee, and Virginia.

The report documents approximately 637 cases of groundwater contamination. Approximately 65% of these cases affect or threaten groundwater supplies, and to date 30 have required new water supplies. The primary sources of information were State agency files and regional U.S. EPA surveys.

The survey is not comprehensive for the nation since it only contains detailed information on ten States. Nevertheless, it may allude to the problem's extent. The information contained in this summary was provided to CRS via telephone.

SOURCE: Environmental Assessment Council
Academy of Natural Sciences of Philadelphia
19th and The Parkway
Philadelphia, Pennsylvania 19103
(215) 299-1109

2. WATER WELL JOURNAL PUBLISHING COMPANY: "ALERT"
Published: bi-weekly [12 pages]
Kevin McCray, Editor
Water Well Journal Publishing Company

SYNOPSIS:

A newletter [begun in January 1982] of ground water contamination news, which is divided into subcontinental areas, i.e., Midcontinent, Northeast, Southeast, West, and Western Great Lakes. Incidents reported range from that of TCE contamination of Missouri water, to radon gas in Maine well water, and to EPA test results in Montana.

Accounts tend to be brief descriptions with relevant information. They do try to provide the names and addresses of organizations involved, especially those of State agencies. This is a useful source of current information on State activities in the field of groundwater.

SOURCE: Water Well Journal Publishing Co.
500 W. Wilson Bridge Road
Worthington, Ohio 43085
(614) 846-4967

3. WATER INFORMATION CENTER, INC.: "THE GROUND WATER NEWSLETTER"
Published: twice monthly [5 pages]
Fred Troise, Editor
Water Information Center, Inc.

SYNOPSIS:

The Water Information Center, a subsidiary of Geraghty and Miller, Inc., is the publisher of this newsletter. It includes information on exploration, development, recharge, management, pollution, and underground waste disposal related to groundwater. Each issue includes single paragraph descriptions in any number of these subject areas, under seven category headings:

1. General
2. Washington Update
3. New Reports
4. Watergrams
5. Research and Developments
6. State Groundwater News
7. International Groundwater News

SOURCE: Water Information Center, Inc.
The North Shore Atrium
680 Jericho Turnpike
Syosset, New York 11791
(516) 921-7690

4. NATIONAL GROUND WATER INFORMATION CENTER: "NATIONAL GROUND WATER INFORMATION CENTER DATA BASE"

Established: 1979
Valerie Orr, Director and System Manager
Claire Fohl, Librarian
National Ground Water Information Center [NGWIC]

SYNOPSIS:

A computerized and retrievable data base of groundwater literature. The NGWIC was created to support the efforts of the National Center for Groundwater Research [NCGWR]. A consortium of Oklahoma, Oklahoma State and Rice Universities, the NCGWR was established by the U.S. EPA in 1979. Oversight is exercised by the EPA Ground Water Research Laboratory [GWRL] in Ada, Oklahoma.

The NCGWR primarily focuses on anticipatory research to identify long-term problems and needs relative to the groundwater resource in the U.S. The NGWIC is affiliated with the National Water Well Association [NWWA] via an EPA grant. The NGWIC has what may be the world's largest cataloged and retrievable collection of groundwater literature, 10,000+ volumes which include: State publications, technical reports, government documents, maps, reference books, and 120 periodicals.

Other data bases available through the system are Lockheed's "DIALOG," and System Development Corporation's "ORBIT." These two systems can then provide access to more than 150 other data bases such as "GEOREF", "GEOARCHIVE", "IRIS", "POLLUTION ABSTACTS", "ENVIROLINE", and "AQUALINE." Information in up to 22 fields may be contained in the references.

SOURCE: NATIONAL GROUND WATER INFORMATION CENTER DATA BASE (NGWICDB)
National Ground Water Information Center (NGWIC)
500 W. Wilson Bridge Road
Worthington, Ohio 43085
(614) 846-9355

Table 14: U.S. EPA Drinking Water System Size Categories

Category	Population Served	Number of CPWS	% of CPWS	% Population*
Very Small	25-500	38,400	65.1	2.4
Small	501-3,300	13,800	23.3	8.3
Medium	3,301-10,000	3,900	6.5	9.8
Large	10,001-100,000	2,700	4.6	32.8
Very Large	100,000+	276	.5	46.7
	Total	59,076	100.0	100.0

* Percent of the total U.S. population of 227 million in 1980.

NOTE: CPWS: A Community Public Water Supply System.

Purchased Systems: A municipality or water company which sells part of its water supply to a second user.

These numbers reflect the double counting effect of including purchased water systems in the community water supplies; nevertheless, the distribution should be fairly representative.

SOURCE: Adapted from "A Status Report: The National Public Water System Program," May 1982, Office of Drinking Water, U.S. EPA.

Table 15: Annual Fresh Groundwater Withdrawals in the United States [1980]

	FRESH WATER*				
Category	Groundwater	[%]	Surface Water	[%]	Total
Rural Domestic and Stock	4.5	[80.4]	1.1	[19.6]	5.6
Irrigation	60.0	[40.0]	90.0	[60.0]	150.0
Public Drinking Water	12.0	[35.3]	22.0	[64.7]	34.0
Self-Supplied Industrial	12.0	[6.6]	170.0	[93.4]	182.0
Total	88.5	[23.8]	283.1	[76.2]	371.6

* In billions of gallons per day.

NOTE: Percentages are based on the category [row] total.
Natural groundwater quality can vary widely between freshness and salinity.

The position paper notes that "Groundwater provides 23 percent of the fresh water used in the United States. In the semi-arid western States, it provides 38 percent of the fresh water supply. It is the chief supply for rural domestic and stock use, and for small community supplies throughout the nation."

At least 35% of public water supplies are derived from groundwater. Thirty-four of the 100 largest cities depend completely or in part on groundwater. The largest communities served entirely by groundwater include: the Nassau and Suffolk Counties on Long Island, New York [2.6 million]; Miami, Florida [1.6 million]; San Antonio, Texas [1.1 million]; Memphis, Tennessee [.9 million]; Dayton, Ohio [.8 million]; Honolulu, Hawaii [.7 million]; and Tucson, Arizona [.5 million].

SOURCE: Adapted from "Groundwater Resources: Definition, Significance, How to Manage Better", a draft position statement presented by the American Institute of Professional Geologists in Washington, D.C. on January 17, 1983.